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NATIONAL DAM SAFETY PROGRAM. SUNSET LAKE DAM (NJ-00063), DELAWA--ETC(U)
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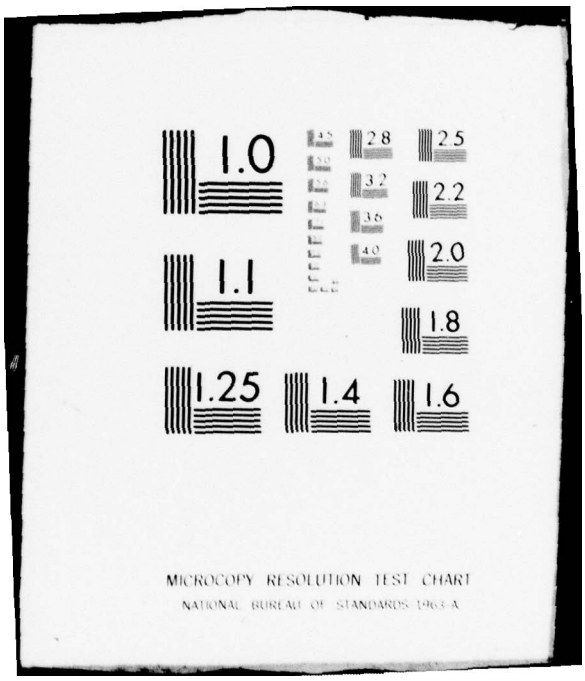
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SUNSET LAKE DAM
NJ 00063

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

April, 1979

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REPORT DOCUMENTATION PAGE

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(6) National Dam Safety Program. Sunset Lake Dam (NJ-00063), Delaware River Basin, Cohansey River, Cumberland County, New Jersey. Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams
Spillway
Structural Analysis
Safety
Visual Inspection
National Dam Inspection Act Report
Sunset Lake Dam, N.J.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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IN REPLY REFER TO

NAPEN-D

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, NJ 08621

4 MAY 1979

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Sunset Lake Dam in Cumberland County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Sunset Lake Dam, a high hazard potential structure, is judged to be in good overall condition. The dam's three spillways are considered inadequate since 17 percent of the Probable Maximum Flood would overtop the dam. The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the fact that failure from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillways' adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillways and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system, should be promptly developed. Also, during periods of unusually heavy precipitation, around the clock surveillance should be provided.

b. Within six months from the date of approval of this report, engineering studies and analyses should be initiated to determine the dam's embankment and foundation condition and structural stability. This

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should include test borings to determine material properties relative to stability and seepage and installation of piezometers to facilitate seepage studies. Any remedial measures found necessary should be initiated within calendar year 1980.

c. Within six months from the date of approval of this report, engineering studies and analyses should be initiated to review the hydraulic operation of the overall structure. Studies should include the effect of restricting the flow under bridge B-14 on Park Avenue, the installation of a log boom for debris collection at the siphon spillway, and the possible construction of an auxiliary spillway in the north end of the raceway dike.

d. Within three months from the date of approval of this report, the following remedial actions should be completed:

(1) Inspect and refill the downstream stilling basins at both main embankment spillways. Consideration should be given to installing energy attenuation devices such as deflecting walls, wider dentated aprons etc. or extending a paved or riprapped channel (especially at the auxiliary spillway).

(2) Regrade and protect scoured areas of main embankment backslopes. Remove trees in selected areas where their presence exacerbates the erosion problem.

(3) Repair deteriorated concrete surfaces on all spillway structures.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman William J. Hughes of the Second District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

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NAPEN-D
Honorable Brendan T. Byrne

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Dirk C. Hofmann, P.E., Deputy Director
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
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John O'Dowd, Acting Chief
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Division of Water Resources
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P. O. Box CN029
Trenton, NJ 08625

SUNSET LAKE DAM (NJ00063)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 10 January 1979 by Louis Berger and Associates, Inc. under contract to the State of New Jersey. The state, under agreement with the U. S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Sunset Lake Dam, a high hazard potential structure, is judged to be in good overall condition. The dam's three spillways are considered inadequate since 17 percent of the Probable Maximum Flood would overtop the dam. The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the fact that failure from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillways' adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillways and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system, should be promptly developed. Also, during periods of unusually heavy precipitation, around the clock surveillance should be provided.

b. Within six months from the date of approval of this report, engineering studies and analyses should be initiated to determine the dam's embankment and foundation condition and structural stability. This should include test borings to determine material properties relative to stability and seepage and installation of piezometers to facilitate seepage studies. Any remedial measures found necessary should be initiated within calendar year 1980.

c. Within six months from the date of approval of this report, engineering studies and analyses should be initiated to review the hydraulic operation of the overall structure. Studies should include the effect of restricting the flow under bridge B-14 on Park Avenue, the installation of a log boom for debris collection at the siphon spillway, and the possible construction of an auxiliary spillway in the north end of the raceway dike.

d. Within three months from the date of approval of this report,

the following remedial actions should be completed:

(1) Inspect and refill the downstream stilling basins at both main embankment spillways. Consideration should be given to installing energy attenuation devices such as deflecting walls, wider dendated aprons etc. or extending a paved or riprapped channel (especially at the auxiliary spillway).

(2) Regrade and protect scoured areas of main embankment backslopes. Remove trees in selected areas where their presence exacerbates the erosion problem.

(3) Repair deteriorated concrete surfaces on all spillway structures.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 4 May 1979

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam Sunset Lake Dam Fed ID# NJ 00063 and NJ ID# 228

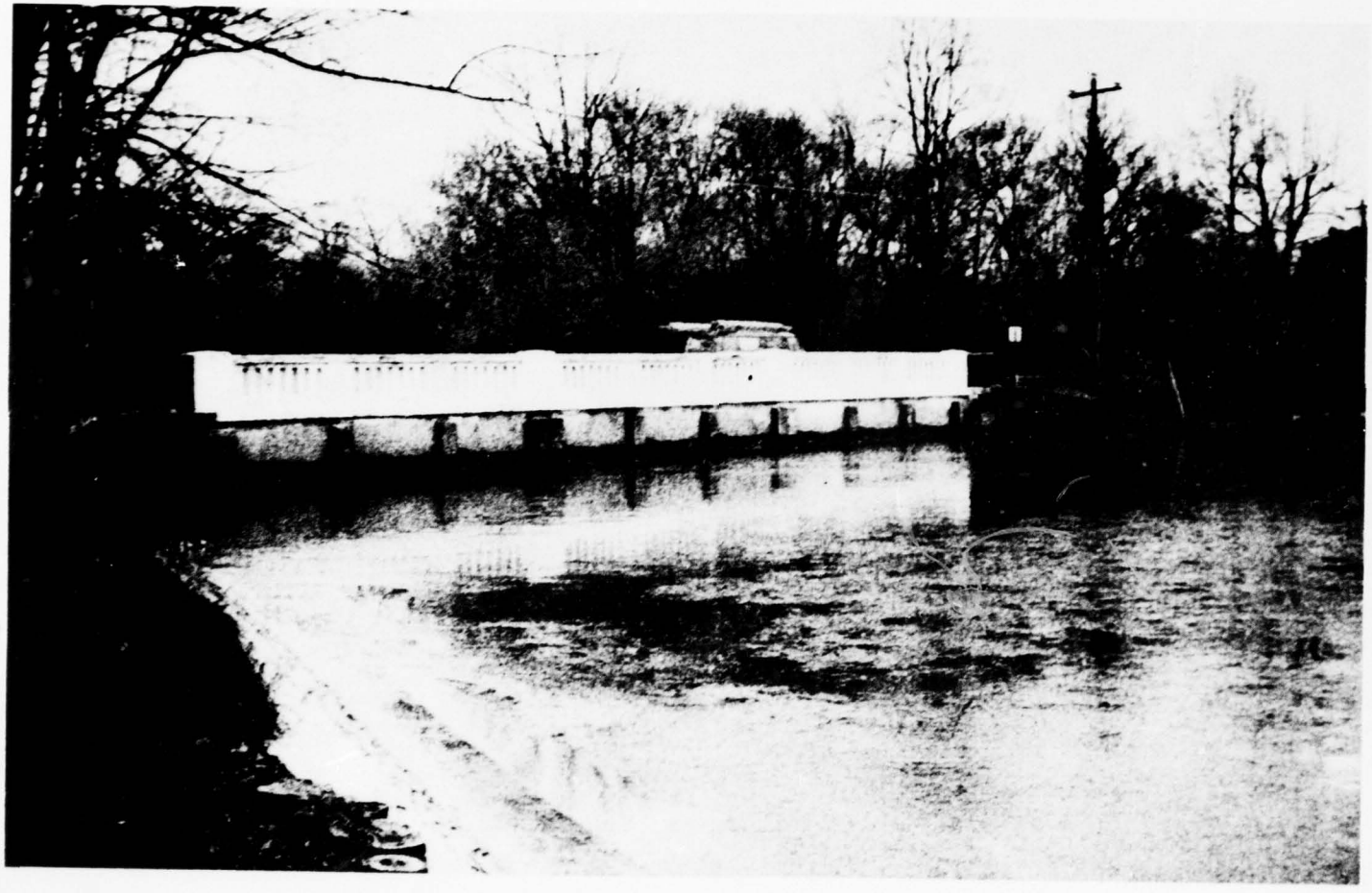
State Located New Jersey
County Located Cumberland
Coordinates Lat. 3926.8 - Long. 7514.2
Stream Cohansey River
Date of Inspection 10 January 1979

ASSESSMENT OF GENERAL CONDITIONS

Sunset Lake Dam is assessed to be in an overall good structural condition but seepage was observed at several locations. No seriously detrimental conditions were observed except the hydraulic efficacy during flooding is questionable and further engineering studies are recommended to be undertaken in the future to assess the feasibility of restricting the flow into the raceway, the installation of a log boom at the siphon spillway and the construction of an additional crest spillway at the north end of the raceway dike. Recommended remedial actions to be undertaken in the future include 1) inspect and refill the stilling basins at both Park Avenue outlets, 2) regrade and protect the main embankment backslopes in the vicinity of the spillways, and 3) repair the exposed concrete surfaces on all spillway structures.

The capacities of the three spillways will accommodate only 16% of the full PMF design flood but the dam is not assessed as unsafe, non-emergency, for this reason as the existing conditions do not meet the requirements of ETL 1110-2-234 in the opinion of the inspection team.

F. Keith Jolls P.E.
Project Manager



OVERVIEW OF SUNSET LAKE DAM

JANUARY 1979

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM: SUNSET LAKE DAM FED ID# NJ 00063

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Engineer District, Philadelphia, to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of the Sunset Lake Dam and appurtenant structures, and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

Sunset Lake Dam is comprised of a 45-year old highway embankment built in conjunction with a very old (160± years) mill raceway dike portions of which pass through a 1,100 acre park in the City of Bridgeton. The highway embankment is approximately 1,200 feet long and carries Park Drive across the entire south shore of Sunset Lake. The mill raceway exits uncontrolled from the southwest corner of the lake and flows over 5,000 feet south through the park where it discharges through a spillway back into the Cohansey River. The main (west) spillway under Park Drive consists of a concrete highway culvert

with nine siphon spillways and two 4'x5' hand-operated vertical lift gates. Approximately 800 feet east of the siphon spillway is an auxiliary 5'x9' culvert with two 42" diameter sluice gates built into a concrete drop inlet entrance. As can be seen on Figure 2, the entire dam thus forms a lengthy 6,200 foot containment structure in the center of the city.

b. Location

Sunset Lake Dam is located in the City of Bridgeton, Cumberland County and is built across the Cohansey River 1.2 mi. north of the intersection of State Highway 49 and 70. It forms the northerly boundary of the City Park, which contains the Cohanzick Zoo.

c. Size Classification

The maximum height of the dam is 20 feet at the siphon spillway and the maximum storage is estimated to be 835 acre-feet. Therefore, the dam is placed in the small size category as defined by the criteria of Recommended Guidelines for Safety Inspections of Dams (storage impoundment less than 1,000 acre-feet).

d. Hazard Classification

Based upon the Corps of Engineers criteria and the fact that in the event of a failure substantial losses of both life and property could be inflicted on the City of Bridgeton the dam is classified to be high hazard. In the downstream environs, there are extensive commercial and residential developments as well as the city zoo, waste water treatment plant and three key bridges which provide the only intracity connections to each side of the Cohansey River.

e. Ownership

According to N.J.D.E.P. Division of Water Resources records the dam embankment and appurtenant structures on Park Drive are owned

by Cumberland County with the operation and maintenance being handled by the City Parks Department with engineering assistance from the City Engineer's Office as required. The portion of the dam within the City Park is owned by the City.

f. Purpose of Dam

The dam presently impounds a recreation lake and scenic canal and is also used as a water supply intake for the City of Bridgeton. In earlier times, an old mill was located at the south end of the raceway and employed the inflow as a power source for a post-revolutionary period nail works.

g. Design and Construction History

The main dam structure as it exists today was constructed in 1938 following a failure in August 1934 which inflicted heavy damage upon the city. The "Bridgetown" raceway was built in 1814. A second near-failure occured in September 1935. The earlier dam (situated north of the present spillway) was also a highway embankment and contained an outlet structure with nine hand-operated wooden gates. The reason for the dam's failure and subsequent near-failure was reportedly due to insufficient discharge capacity through the wooden gates. Following the 1935 flood, the City was ordered to maintain the lake in a dewatered condition until a new spillway could be constructed. After considerable design and approval delays, the new siphon spillway was completed in 1938 and was the first of its kind to be built in the eastern United States. However, the dam failed again due to overtopping in 1940. This was attributed to a combination of heavy rains, the breaching of dams at Mary Elmer Lake and Seeleys Mills Pond upstream, and the clogging of the siphon inlets by floating debris. During this flood, Park Drive was reputedly overtopped by about 8 feet. As a result, applications for the construction of a log boom and the clearing of

the downstream channel were applied for but this work was never carried out. In 1950 an extreme high tidal tailwater condition in the downstream channel occured (estimated to have reduced the flow through the siphons by 13%) and the dam was nearly overtopped again. Whereupon, the Chief of the Bureau of Water Control personally urged the City to remove trees and clear debris from the downstream channel. This work and subsequent minor repairs were undertaken by the City but in 1975, the dam at Mary Elmer Lake failed and Sunset Lake Dam was breached in several places along the tailrace embankment within the park lands. This damage was subsequently repaired.

h. Normal Operating Procedures

Personnel of the City engineering staff and Parks Department normally attend the operating facilities and conduct normal maintenance. (See Section 4).

1.3 PERTINENT DATA

a. Drainage Area

The drainage area of Sunset Lake Dam is 45.7 square miles.

b. Discharge of Dam Site

The spillway capacity with the reservoir at the abutment top elevation is calculated to be approximately 5,400 cfs. Some discharge records are available for this site. (See Section 5).

c. Elevation (Above M.S.L.)

Top of dam - +20.0
Recreation Pool - +16.06
Streambed at Center Line of Dam - varies (0 to +2)

d. Reservoir

Length of Recreation Pool - 4,000 feet
Length of Maximum Pool - 6,600 feet

e. Storage

Recreation Pool - 310 acre-ft.
Top of dam - 835 acre-ft.

f. Reservoir Surface

Top of dam - 169 acres
Recreation Pool - 94 acres

g. Dam

Type - Earth embankment with concrete siphon spillway and two auxiliary sluiceways.

Length - 1,500 feet @ Elev. 20+
- 4,700 feet @ Elev. 18 to 19+
Total - 6,200 feet

Max. height - 20 feet (concrete spillway structure)

Freeboard between normal reservoir and top of dam - 4.0 feet

Top width - 30+ feet (main embankment)

Side slopes - 1.5H & 2H:1V

Zoning - composition and compactness unknown

h. Diversion and Regulating Tunnel

None

i. Spillways

1) Main Spillway

Type - reinforced concrete siphons (2'-6" x 8'-0" throats) with auxiliary sluice gates

Inlet Elevation - +16.06

2) Auxiliary Spillway (at south end of raceway)

Type - hooded notched-weir drop inlet with vertical trashbars

Crest Elevation - +15.69

Length of weir - 19 feet

j. Regulating Outlets

1) 2-42" Ø steel sluice gates on main dam embankment (at 5'x9' concrete culvert)

2) 2-4'x5' steel sluice gates at siphon spillway.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Portions of the 1935 design documents for the construction of the main spillway siphons were available in addition to earlier (undated) plans for the construction of the drop inlet at the south end of the raceway. No design computations were located for the structural analyses of any of the major dam components nor were details available regarding the auxiliary 42-inch sluice gates in the middle of the Park Avenue embankment. Portions of the hydraulic computations were available for the siphons but consisted principally of data filed with Dam Application No. 228, (dated November 13, 1934). The design was undertaken by Mr. Walter M. Sharp, P.E. the Cumberland County Engineer at that time.

2.2 CONSTRUCTION

Nothing is known about the construction except final drawings were filed with the State in August, 1937. The work was undertaken by C. Fiske Campbell, General Contractor and was completed in April of 1938. The present field inspection revealed that the spillway was constructed in accordance with the design plans.

The two 42" circular sluice gates near the west end of the Park Drive embankment were in existence prior to 1935 but nothing is known regarding their installation.

2.3 OPERATION

In recent years, the dam appears to have operated satisfactorily except for the 1975 flood when its breaching was apparently caused by upstream dam failures.

2.4 EVALUATION

a. Availability

Sufficient engineering data is believed to be available to assess the overall condition,

safety and hydraulic characteristics of the Sunset Lake Dam. No data was uncovered regarding the composition of the embankments (especially the zones of the raceway dike near its north end).

b. Adequacy

The original plans reveal that the main spillway was carefully designed and constructed in accordance with the contract plans. It is felt that the data reviewed was adequate upon which to base a Phase I assessment. However, additional geotechnical information, including material properties, piezometer readings and permeability analysis would be required for complete evaluation of the embankment zones.

c. Validity

The validity of the engineering data made available is not challenged and is accepted but further investigations are recommended to assess the long-term stability of the embankments.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

Visual inspections were conducted on January 10 and 11, 1979 after an initial inspection (on December 22nd) indicated the complexity of the dam configuration. In general, the dam was observed to be in a satisfactory condition commensurate with its age although it appeared that there had been little maintenance to the gate structures in recent years. It was noted in the Dam Applications, reports and various correspondence that only the 1,200 foot section of embankment along Park Drive has been referred to as the dam structure but the lengthy dike paralleling the "Bridgetown" raceway forms a contiguous and integral part of the overall hydraulic structure (see Figure 2). The County Bridge No. B-14 (built in 1935) located at the intersection of Park Drive and Mayor Aitken Drive has no hydraulic effect or gates which affect the lake level but merely provides access for the Park Avenue traffic across the main dam crest and discharge into the raceway.

b. Dam

The main embankment carrying Park Drive across the south end of Sunset Lake is quite wide (over 30 feet) in comparison to its height (9 to 15 feet). Much of the embankment has been in position a considerable length of time except for a 120 foot portion to the east of the main spillway where the original channel existed below Tumbling Park Dam. In this old channel, 30 foot lengths of interlocking steel sheeting were driven in the 1938 work to seal off the existing channel flow. The sideslopes appear to have been originally built at 1:1 but are now heavily wooded and misshapen with brush, concrete and masonry rubble present on the backslopes. Extensive areas have flattened out due to sloughing to roughly 2H:1V slopes. The Lake Drive roadway has been

recently repaved and no major subsistence areas were observed. However, the surface run-off has seriously eroded the backslopes in several areas especially at the downstream wingwalls of the siphon spillway. The erosion behind the west wing is severe and the embankment stands aalmost vertical. The pavement run-off appears to be a continual maintenance problem. There are numerous wet areas along the downstream toe where very saturated zones and upward seepage was observed. The natural alluviul soils at the toe are soft and loose. A very wet area was observed between the siphon spillway and the 42" gated auxiliary sluiceway and it appears there may be an earlier natural channel in this area. The backslopes in the vicinity of the 42" sluiceway outfall are heavily eroded and have exposed the upper portions of the headwall. A large stilling basin has scoured out here and has created a standing pond over 120 feet in width. Similarly, the exit energy from the 4' x 5' sluice gates on each side of the main siphon spillway has caused considerable sweepout of the natural channel and undercut the stilling basin apron by several feet.

The embankment that forms the raceway extends southward almost a mile to its terminus just south of Washington Street. It roughly parallels Mayor Aitken (formerly Park) Drive. The raceway flows past the City Zoo and several other recreational facilities and passes under a concrete arch bridge about 1,600 feet north of the raceway outfall. The canal embankment has a crest width of 12 feet at the northerly end but diminishes in some areas to approximately 7 feet near the south end. The backslopes are roughly 2:1 but the canal side is much steeper and in some places is almost vertical. There are numerous locations where earlier drainage structures have been sealed off (opposite Washington Street for example) and old building foundation walls are incorporated into the embankment. Several wet areas were observed at and just beyond the toe of fill and there is an extensive pond and

secondary natural outlet channel just below Park Drive where there appears to be extensive percolation through the raceway embankment. The more southerly portions appear to be considerably older, are quite heavily wooded and contain many walls and building foundations of earlier industrial works.

c. Appurtenant Structures

The main spillway consists of a unique 9 cell reinforced concrete siphon culvert. Each throat opening is 2'-6" by 8'-0" and are flanked by two 4' by 5' steel, hand-operated sluice gates. The siphons are set at slightly varying elevations, formulated after exhaustive design and experimentation. The concrete structure is approximately 90 feet wide overall and has flared wingwalls at each corner. The exit chamber for each siphon is 6'x8' by 48' long and the intake face is protected with wrought iron trash gratings. The entire culvert was constructed within a steel cofferdam which was left in place to form cut-off walls. The structure shows its age. There are several bad cracks in the wingwalls and numerous chipped and spalled areas. The downstream invert apron is only 14 feet wide and is gradually being undercut by the excessive exit velocities. The culvert appears to be at true alignment and grade however and exhibits little differential settlement. The gate stands are freshly painted and in operating order.

The auxiliary spillway on the main dam embankment consists of two 42" hand-operated sluicegates which are situated roughly 800 feet to the west of the siphon spillway. The top of the concrete drop inlet is set at the main spillway elevation (+16) and discharges into a 5' x 9' box culvert. The structure is in good condition but as previously stated, the outlet discharge has created a large pond just below the culvert headwall.

The notched-weir drop inlet at the south end of the raceway (see Figure 3) replaced two

earlier 4' x 4' gates which originally discharged the raceway flow into a timber flume that apparently continued southward to the historic nailworks. The present structure has two 7'-6" and one 4'-0" wide notched weir openings and discharges into a concrete chamber which dumps directly into the Cohansey River through two 36" x 58" elliptical CMP. Although the intake structure is old, it is in an adequately structural condition with no major cracking although the concrete surfaces are badly deteriorated.

d. Reservoir

Sunset Lake extends about 0.8 mile above the dam and is fed directly by the Cohansey River as well as the discharge over the new (1977) Mary Elmer Lake Dam and numerous other smaller brooks. The reservoir was clear of debris at the time of inspection but there are indications upland that trash collection is a maintenance problem. Both shores have steep banks and are flanked by extensive residential development. Immediately upstream from the left abutment there is a small park. The shoreline appears to be quite stable in the vicinity of the dam.

e. Downstream Channel

Below the Park Drive spillway, the Cohansey River is tidal and flows southward roughly one mile where it passes under the Washington Street bridge, immediately adjacent to the raceway outlet. High tides and flooding have apparently been a problem in the past as the lower reaches of the river have timber bulkheads constructed along each bank. The low-lying floodplain is mostly City park property but is not completely utilized and contains a sanitary land-fill operation. Immediately below Washington Street, the river flows under bridges at Commerce and Broad Streets and then releases into a much wider tidal channel.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Operational procedures were not observed by the inspection team but were reviewed with personnel of the City Engineering and Parks Department. After the 1975 flood, the City developed an extensive plan for dealing with flood emergencies which involves personnel of the Parks and Roads and Streets Departments as well as Civil Defense.

4.2 MAINTENANCE OF DAM

The main embankment under Park Avenue and the siphon spillway and bridge are the responsibility of Cumberland County while the City Parks Department maintains the embankment along the raceway which is viewed as being in a well-maintained condition considering funding limitations. There has been no apparent structural maintenance of the Park Avenue portion in recent times except for the operating equipment and facilities.

4.3 MAINTENANCE OF OPERATIONAL FACILITIES

The City maintains and operates all flood gates and tests them every three months. The gates appear to be well-maintained with portions having been recently painted. To circumvent vandalism, the gate cranks are removed from their operating position but three sets of keys and cranks are stored with the City Police, Streets and Roads and Parks Departments as part of their emergency system.

4.4 DESCRIPTION OF WARNING SYSTEM IN EFFECT

As established by the City's emergency plan, Parks, Roads and Streets and police personnel monitor the facility during periods of heavy flow and maintain radio contact with the local Civil Defense authorities.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

The present procedures and safeguards are deemed to be adequate since the City has adopted its

present emergency plan and have trained personnel who diligently pursue the monitoring and operational activities. In the opinion of the inspection team, the City has an experienced well-managed staff who are fully aware of their responsibilities.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data

In accordance with the criteria in the Recommended Guidelines for Safety Inspection of Dams, it has been determined that the dam at Sunset Lake is small in size and is placed in the high hazard category. Accordingly, the spillway design flood (SDF) was determined to be the full probable maximum flood. The inflow hydrograph was calculated using precipitation data from Hydrometeorlogical Report #33. As directed by the Corps of Engineers, the inflow hydrograph and flood routing were performed utilizing the HEC-1 computer program. Peak inflow to the reservoir for the PMF was calculated to be 33,490 cfs and when routed through the reservoir, reduced insignificantly to 33,410 cfs. The two Park Avenue spillways and the trapezoidal opening at Bridge B-14 have capacities before overtopping of approximately 5,400 cfs. This computation was derived on the basis that the hydraulic opening of bridge B-14 functions as an additional auxiliary spillway and the theoretical flow over the raceway dike and its south terminus spillway is not included in the above determination of effective spillway capacity. The overall discharge capacity of the lower crest elevation raceway dike and its spillway are considerably larger than Bridge B-14. Therefore, the spillway will accommodate only 16% of the SDF. This flood would cause the main Park Avenue section of the dam to be overtopped by approximately 4 feet.

b. Experience Data

There is a water quality station at the dam site but there are no streamflow records available. A section of the dam 350 feet in length was washed out in heavy flooding in September 1940. This was caused by heavy

rainfall and the failure of at least one upstream dam. High backwater conditions (which substantially decrease the siphon capacities) may have contributed to the conditions but it was recorded that the high water reached El. +28.12 at the dam crest, an overtopping of roughly eight feet. It is unknown at that time to what extent debris blocked the overflow of the embankment but as the well-recorded high water mark is substantially higher than the computed PMF design overtopping, there were clearly some blockage or a brief surge that reached this elevation.

c. Visual Observations

The siphons appear to be functioning as designed during the periods of inspection and there was a uniform flow in the mill raceway (with a velocity of less than 1 foot per second). There was concern expressed and reaffirmed by Parks Department officials as to the exact instant that the siphons begin functioning. Apparently, the instance of their start-up can vary considerably in time and the auxiliary 4'x5' spillways are used extensively during storms due to this somewhat erratic behavior. The tidal fluctuation in the Cohansey River downstream is considerable and as previously stated, the downstream bridges have limited additional hydraulic capacity if flooding occurs simultaneously with periods of extreme high tide. The downstream bridge at Washington Street is only marginally adequate especially if a flood peak is reached during a period of high tide. Normal high tides can reach El. 4.5± which leaves only about three feet of freeboard under the curved bridge soffit.

d. Overtopping Potential

As previously stated, the PMP design flood overtops the main Park Avenue embankment by about four feet when the bridge B-14 is taken as an auxiliary spillway. However, if the overall dam length (with only a arbitrary lower 200 feet of the raceway dike at El. 18±) is utilized, overtopping of roughly 1.5 feet would occur at the peak of the design flood

for the entire 6,200 foot length. At this instant of overtopping, the auxiliary spillway at the south end of the raceway can accommodate only slightly more than 450 cfs but with the raceway flowing full, only about 350 cfs can reach it because of the restricted capacity of the raceway (due primarily to the flat gradient). Hence, the effect of overtopping the total 6,200 foot dam length is somewhat questionable insofar as an overtopping height is concerned. This points up the fact that the hydraulic capacity of Bridge B-14 allows more flow into the raceway that it can adequately accommodate downstream without overtopping. This condition becomes most critical just south of Bridge B-14. If there is a sudden increase in reservoir level, the upper reach of the raceway could overtop its banks and breach the dike at the first bend just below Park Avenue. It was noted that the most recent (1975) failure occured here. The top of berm crest in this area of the raceway dike is roughly one foot below the elevation of the main dam crest. A possible remedial measure to be further studied here is briefly discussed in Sections 6 and 7.

e. Drawdown Potential

Assuming drawdown is accomplished through the two 4' x 5' sluice gates, Sunset Lake would take approximately ½ day to dewater to El. 4.5 or 11.6 feet below the normal lake level. (The drawdown time is based on the assumption of a modest inflow and an average tailwater elevation).

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

As a result of the field inspections and the review of the portions of the design plans that were available, the structural stability of the Sunset Lake Dam is felt to be moderately good although the overall structure is susceptible to overtopping. The main embankment under Park Drive has a relatively large width to height ratio and at the present time is in little danger of a stability failure (although there are numerous areas where there appears to be heavy seepage and percolation through the foundation soils). Further, the continued sweepout of the stilling basins of the main siphon and 42" auxiliary spillways sooner or later will require remedial repairs. The auxiliary sluice gates at each end of the siphon spillway appear to cause considerable scouring and there is no present provision for energy attenuation devices. This, coupled with the erosion of the fill slopes behind the downstream wingwalls is gradually undermining the downstream toe in this area. Although little details were available to review regarding specifics of the reinforcing, thickness of members, design assumptions and allowable soil bearing pressures, the siphon spillway is not overly complicated from a structural viewpoint. Further, although designed by County Engineer Sharp, the plans were reviewed and ultimately approved by the State Highway Department's Division of Bridges. However, it is felt that in view of the age of the structure, it should be thoroughly inspected sometime in the future, especially along the downstream apron and internally, including the venting system.

The 9 x 5 foot auxiliary spillway culvert and the 42" sluice gates are in satisfactory condition but there has been some minor differential shifting

and the concrete surfaces in some areas are surficially spalled. County Bridge B-14 (at the west end of the Park Drive embankment) is in an old but satisfactory condition although it has a shallow headroom for accommodating the raceway flow beneath it. Its hydraulic capacity does not appear to restrict the flow into the raceway but on the contrary, appears to allow more water in than the raceway than it can handle. As discussed in Section 5, the discharge capacity of the drop inlet at the south end of the raceway is limited and as near as could be determined, there is an extremely flat gradient on the mile long canal. Hence, a rapid rise in the lake level chokes up the canal immediately after passing under bridge B-14 and could overtop the dike embankment on the left (in the vicinity where the 1975 breaching occured). The remainder of the dike embankment for the raceway is old but in a well-maintained condition. A breaching of its upper end presents little serious hazard but an overtopping of the lower portion could flood Mayor Aitken Drive, several park facilities and the City water supply station at Washington Street. The notched-weir drop inlet at the south end of the raceway is in satisfactory condition but the hood and walls are cracked and eroded and should be renovated. The trash racks were clear of debris at the time of inspection but appear to be a minor maintenance problem.

b. Design and Construction Data

Summarizing Section 2, no detailed design computations or construction plans were available to fully assess all of the elements of the spillway structures but sufficient overall plans and dimensions were obtained from the City which, together with the field observations, reveal a conservative, well-engineered design. Based on the condition of the dam, its position and size of reservoir, it is believed that additional structural studies are unnecessary. However, as set forth in Section 7, additional hydraulic review could possibly result in upgrading the long-term safety and operating characteristics.

c. Operating Records

The performance of the spillway structures appear to have been satisfactory except for the 1975 breaching. There are no records regarding operational deficiencies in the siphons except as previously noted, there is always a concern during floods as to exactly when they go into operation.

d. Post Construction Changes

There have been no major modifications since the initial construction of the main elements of the dam as they exist today. The upper sections of the raceway dike were rebuilt after the 1975 breaching. Many other numerous minor repairs appear to have been undertaken since 1938.

e. Seismic Stability

The dam lies in Zone 1 and has negligible potential vulnerability to seismic loadings. Soils in the vicinity of the dam consist mainly of stratified alluvial deposits of Cap May and possibly the Bridgeton formations and are basically narrow-graded sands and silty sands. Hence subsurface liquification is deemed not to be a consideration. The depth to bedrock is greater than one hundred feet. Experience indicates that dams having adequate stability under static loading conditions in Zone 1 will also have adequate stability under dynamic loading conditions.

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS/ REMEDIAL SECTIONS

7.1 DAM ASSESSMENT

a. Safety

Subject to the inherent limitations of the Phase I visual inspection, Sunset Lake Dam is judged to be in an overall sound structural condition although the combined spillways are capable of discharging only 16% of the full PMF design flood. However, the dam is adjudged not to be unsafe non-emergency as it does not meet the requirement of ETL-1110-2-234 in the opinion of the inspection team. There is no economically feasible way of increasing the present discharge capacities and the potential for overtopping the northernmost section of the raceway dike remains considerable. No detrimental findings, except for seepage flows in numerous areas, were observed which cannot be alleviated by the remedial repairs enumerated below. Although the theoretical overtopping of the entire dam is less than two feet, the restricted hydraulic capacity of the raceway places the overall structure in a somewhat precarious position as far as future breaching of the raceway dike is concerned. Its northernmost zone is felt to be a hydraulic weak link in the overall dam system.

b. Adequacy of Information

The information obtained for the Phase I inspection is deemed to be adequate for the enclosed assessment but additional geotechnical information would be required should additional studies be undertaken regarding the seepage.

c. Urgency

No immediate urgency is attached to implementing any further studies or the remedial measures set

forth below. These can be undertaken in the future as a part of the regular maintenance program of the City and County.

d. Necessity for Further Study

In view of the downstream conditions reflecting the high hazard classification, further studies are recommended relating to the seepage and hydraulic operations.

7.2 RECOMMENDATIONS/REMEDIAL ACTIONS

a. Alternatives

- Inspect and refill the downstream stilling basins at both main embankment spillways. Consideration should be given to installing energy attenuation devices such as deflecting walls, wider dendated aprons etc. or extending a paved or riprapped channel (especially at the auxiliary spillway).

- Regrade and protect scoured areas of main embankment backslopes. Remove trees and root systems in selected areas where their presence exacerbates the erosion problem.

- Sandblast and patch concrete surfaces on all spillway structures.

- Conduct an in-depth engineering analysis of the dam, including subsurface investigations (with the necessary tests to insure the long-term stability) and review the hydraulic operation of the overall structure. Studies should include the effect of restricting the flow under bridge B-14 on Park Avenue, the installation of a log boom for debris collection at the siphon spillway, and the possible construction of an auxiliary spillway in the north end of the raceway dike.

b. O&M Maintenance and Procedures

No additional procedures other than those currently in effect appear to be warranted.

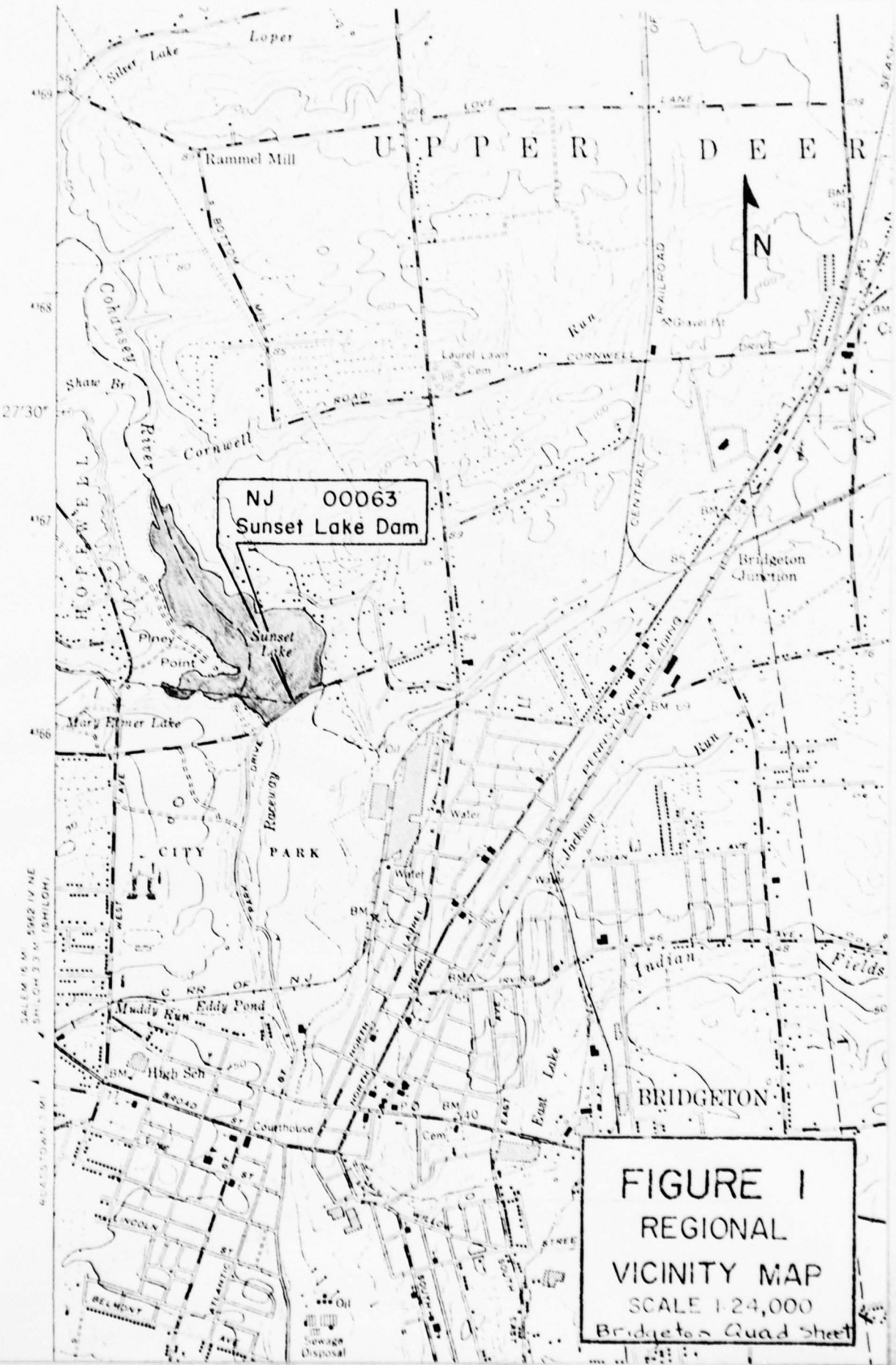
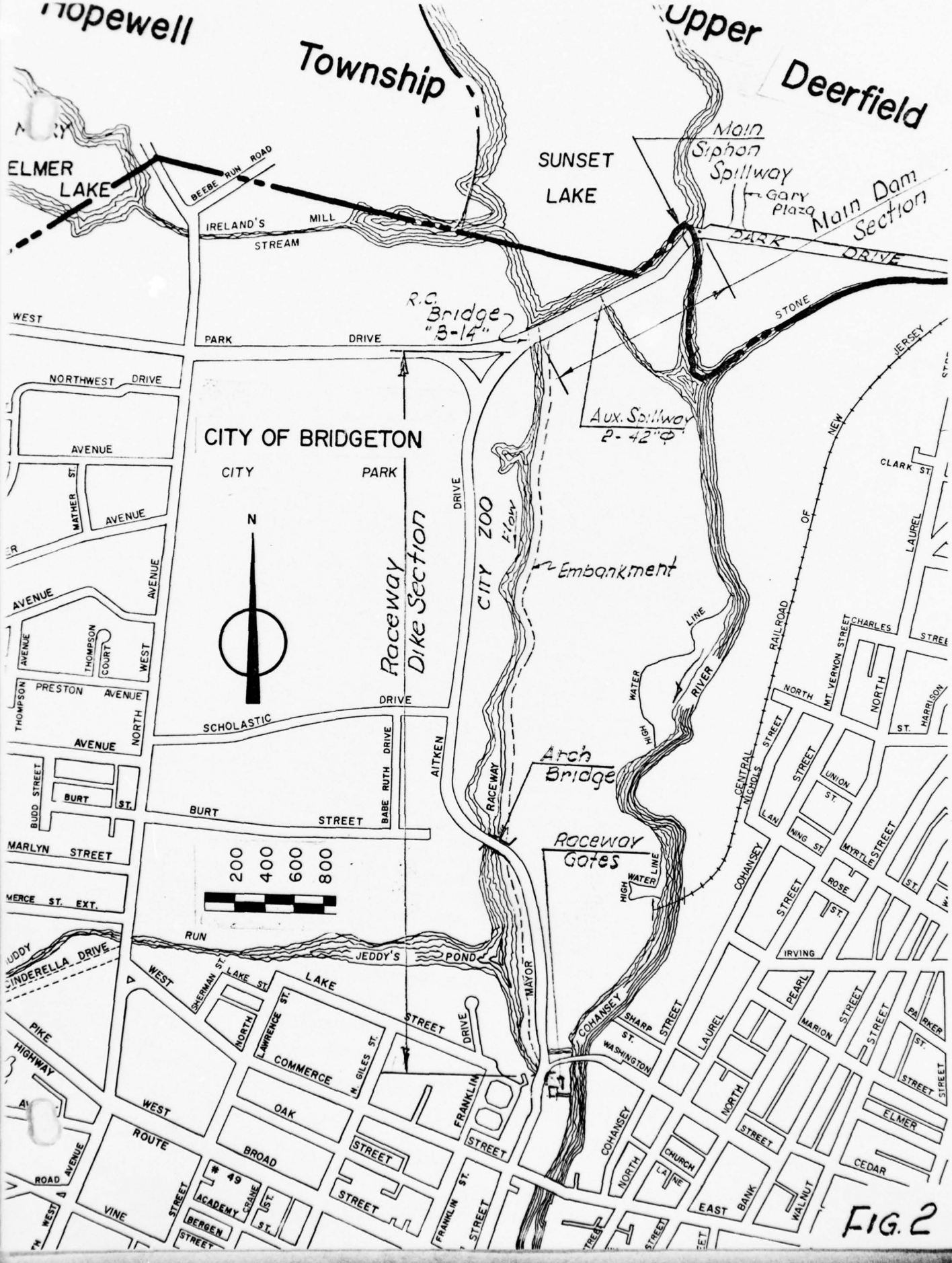
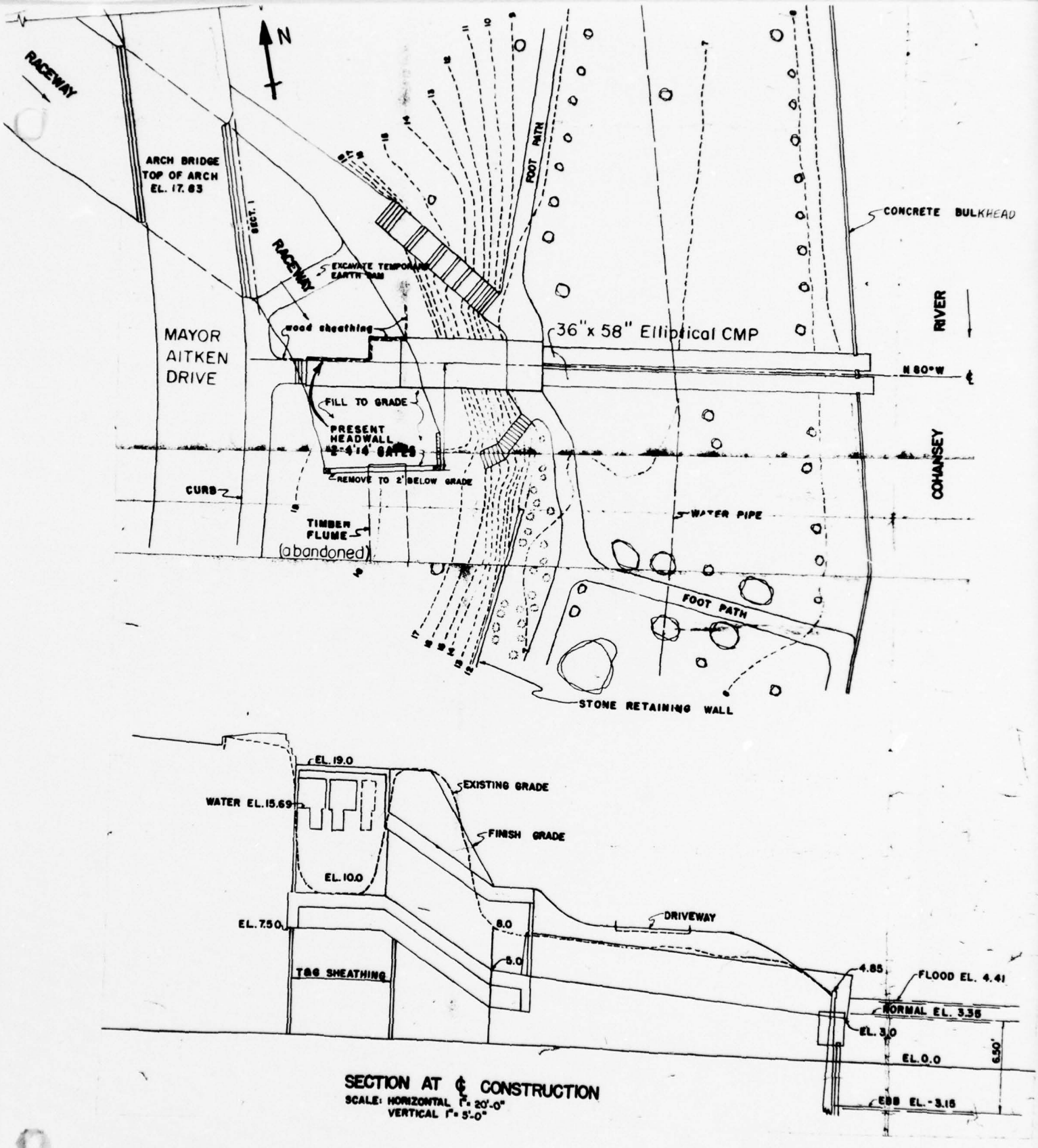


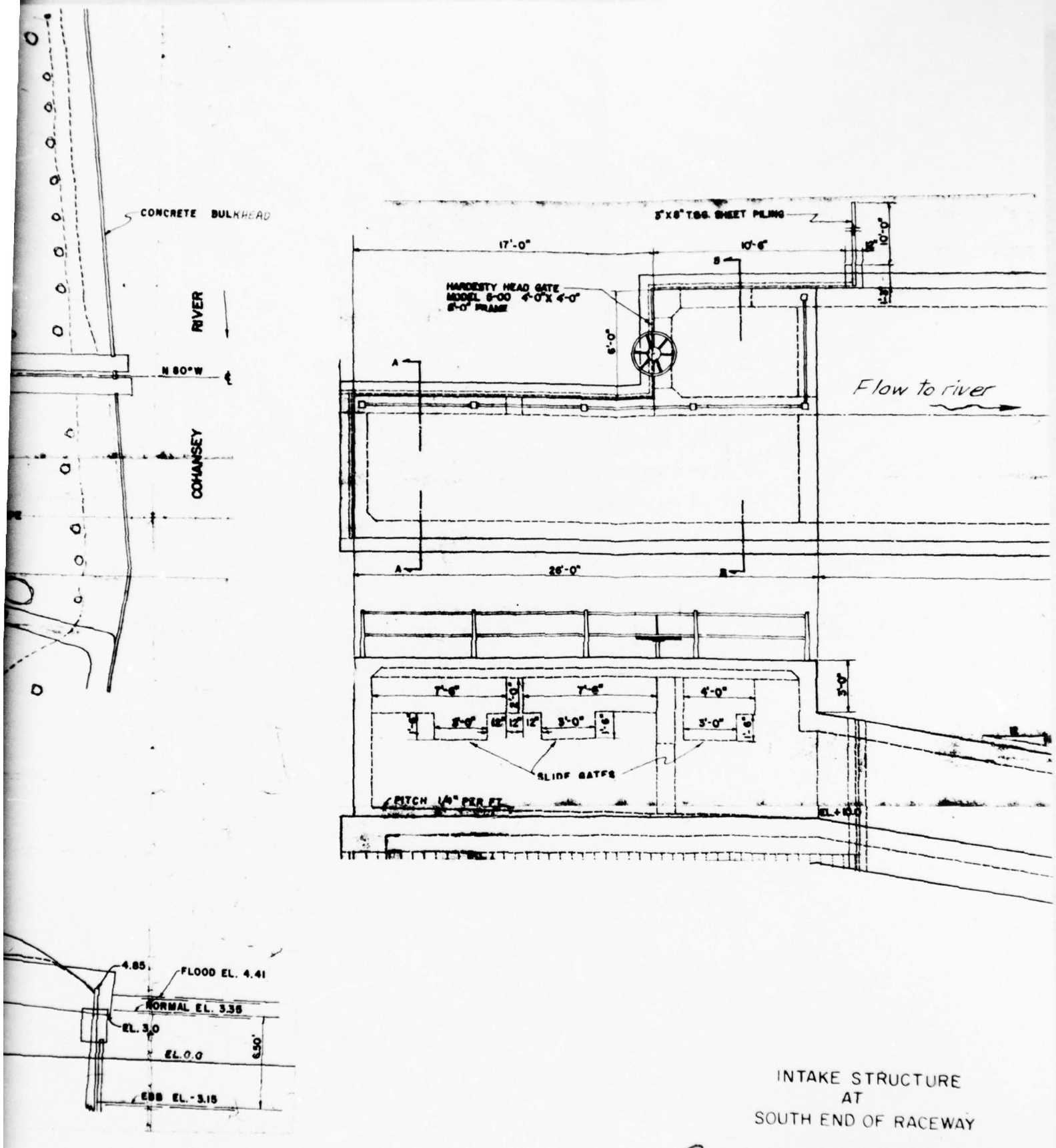
FIGURE 1
REGIONAL
VICINITY MAP
SCALE 1:24,000
Bridgeton Quad sheet


Hopewell
Township
Upper
Deerfield
ELMER
LAKE
BEEBE RUN ROAD
IRELAND'S
MILL
STREAM
SUNSET
LAKE
Main
Siphon
Spillway
Gary
Plaza
Main Dam
Section
PARK DRIVE
R.C.
Bridge
"B-14"
WEST
PARK
DRIVE
STONE
NORTHWEST DRIVE
AVENUE
CITY OF BRIDGETON
CITY
PARK
Aux. Spillway
2-42"Ø
NEW
JERSEY
CLARK ST
LAUREL
N
Raceway
Dike Section
DRIVE
CITY ZOO
View
Embankment
MATHER ST.
AVENUE
THOMPSON
COURT
WEST
PRESTON AVENUE
NORTH
SCHOLASTIC
DRIVE
WATER
LINE
HIGH
RIVER
RAILROAD
CHARLES
STREET
MT. VERNON STREET
NORTH
ST. HARRISON
BUDD STREET
BURT ST.
BURT
STREET
BABE RUTH DRIVE
AITKEN
RACEWAY
Arch
Bridge
CENTRAL
NICHOLS
STREET
UNION
ST.
MARLYN STREET
Raceway
Gates
HIGH WATER LINE
MYRTLE STREET
ROSE
ST.
COHANSEY
STREET
IRVING
MERCE ST. EXT.
RUN
JEDDY'S
POND
MAYOR
SHERMAN ST.
LAKE ST.
LAKE
STREET
DRIVE
PIKE
HIGHWAY
NORTH
LAWRENCE ST.
COMMERCE
N. GILES ST.
SHARP
ST.
WASHINGTON
PEARL
MARION
STREET
LAUREL
STREET
WEST
OAK
FRANKLIN
STREET
ROUTE
BROAD
STREET
COHANSEY
NORTH
CHURCH
LANE
ELMER
STREET
CEDAR
ROAD
AVENUE
49
ACADEMY
CRANE
ST.
EAST
BANK
WALNUT
VINE
STREET
BERGEN
STREET
FRANKLIN ST.
STREET
200
400
600
800
FIG. 2



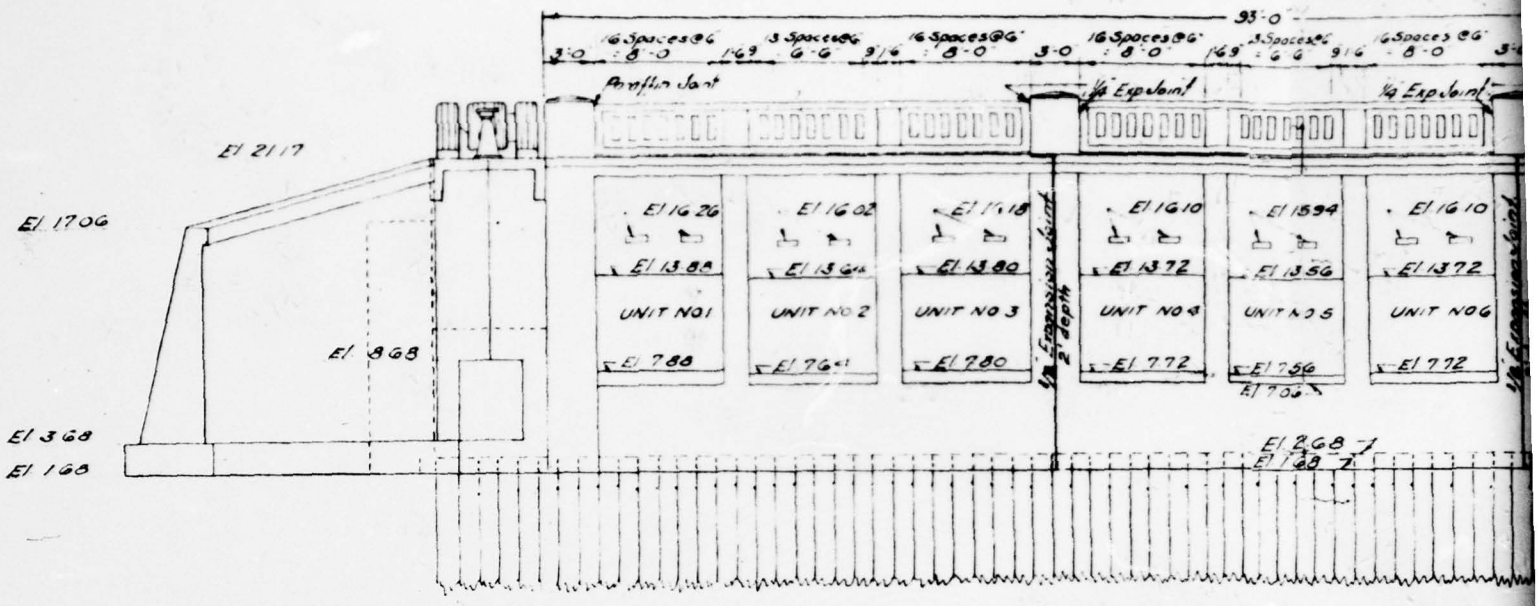
SECTION AT ℄ CONSTRUCTION

SCALE: HORIZONTAL 1" = 20'-0"
VERTICAL 1" = 5'-0"



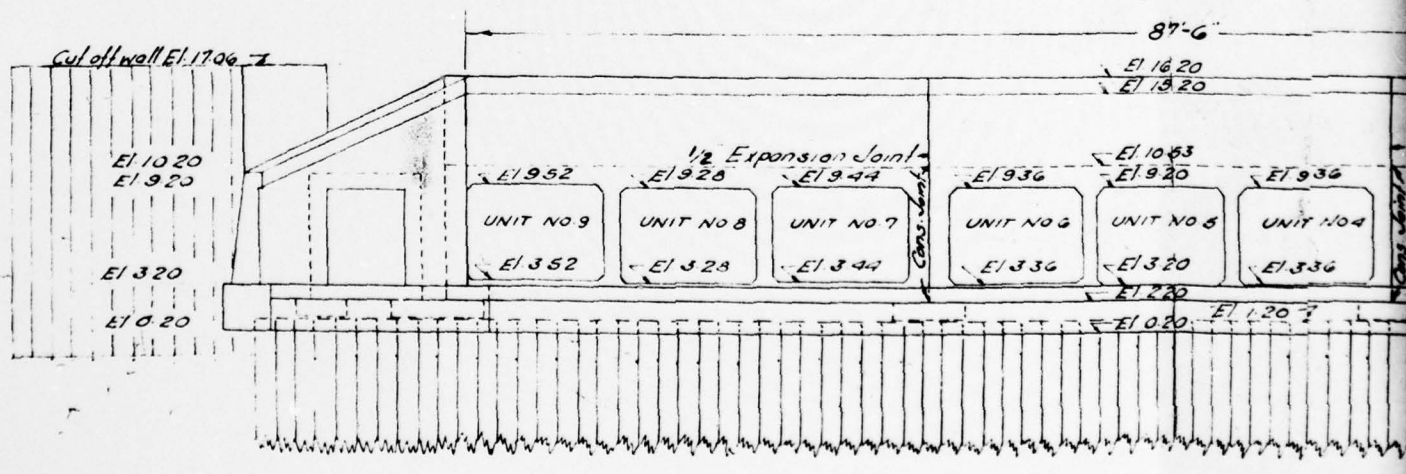
INTAKE STRUCTURE
AT
SOUTH END OF RACEWAY

FIGURE 3



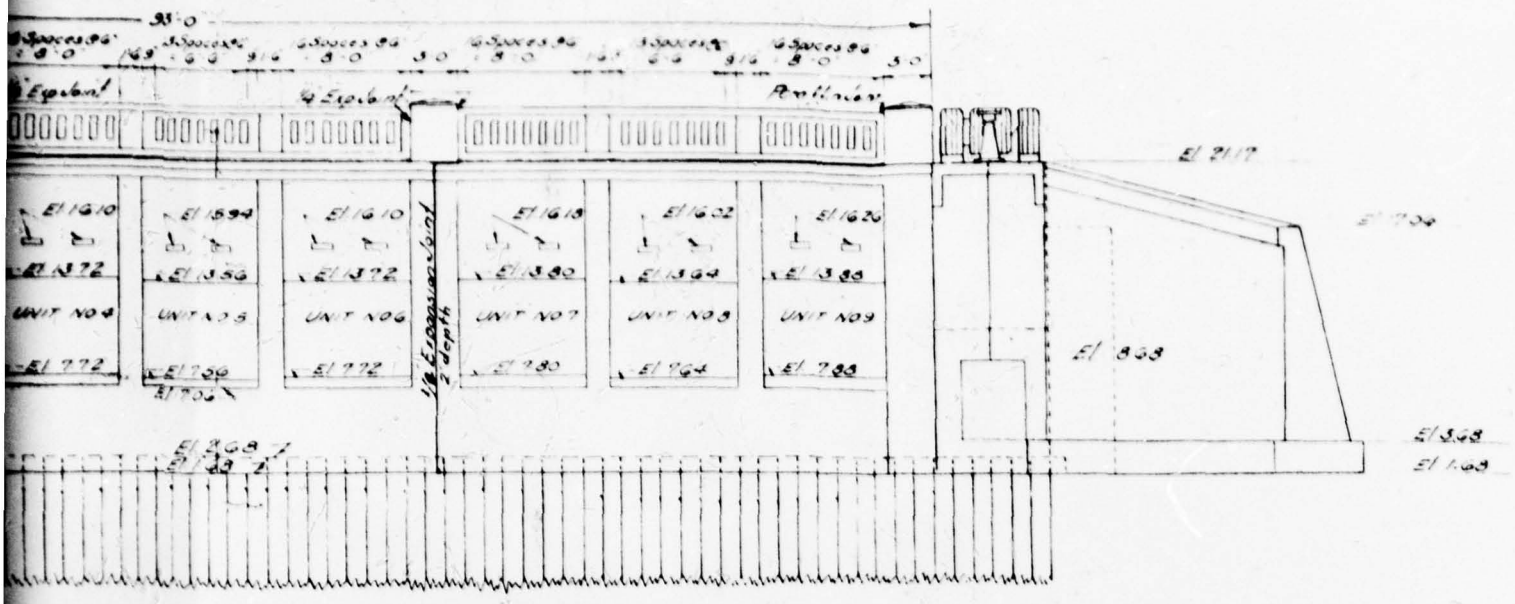
ELEVATION LAKE SIDE

Scale 1/8" = 1'-0"



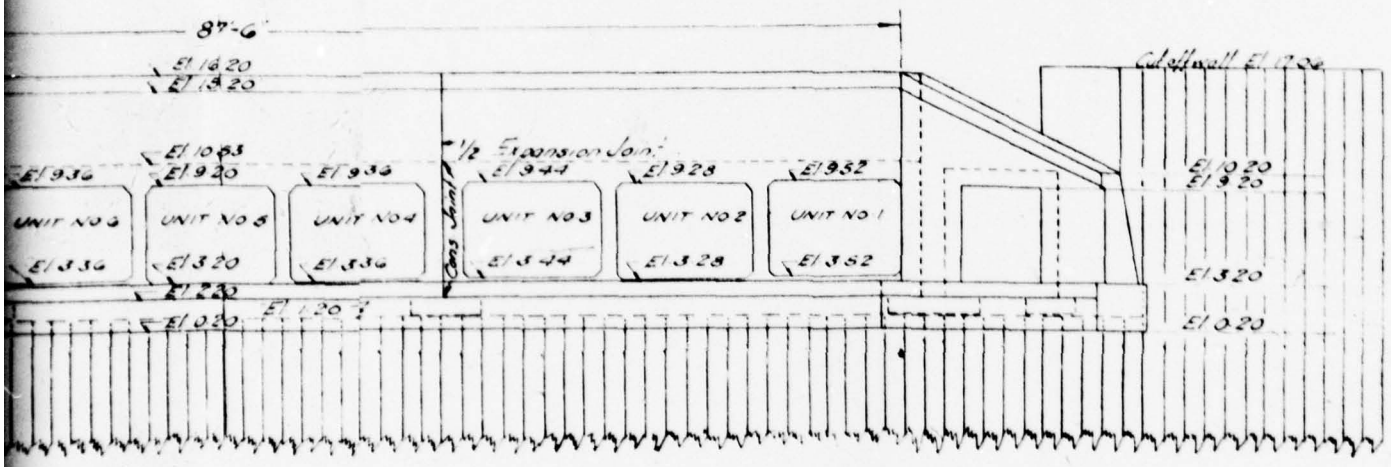
ELEVATION STREAM SIDE

Scale 1/8" = 1'-0"



ELEVATION LAKE SIDE

Scale 1/8" = 1'-0"



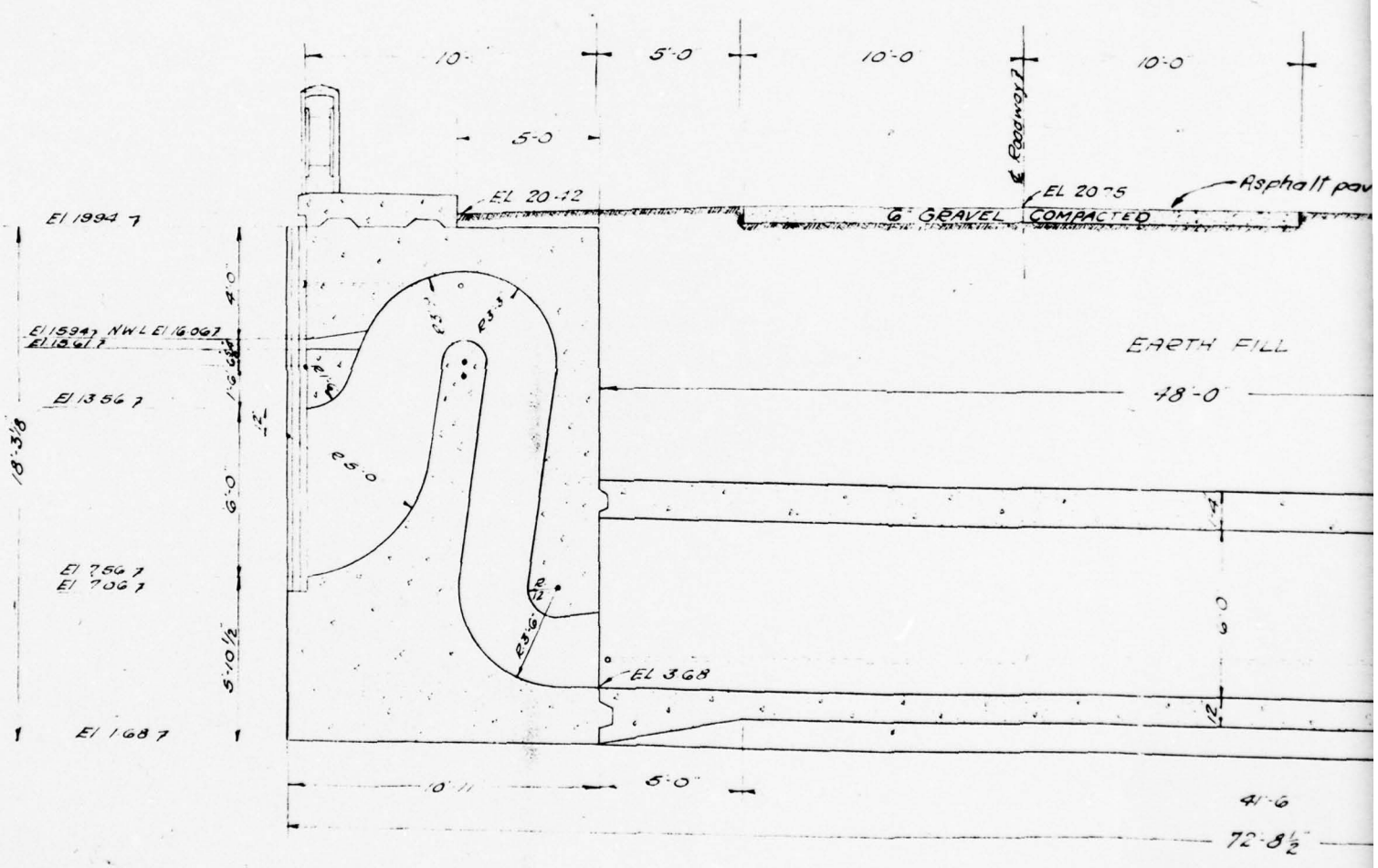
ELEVATION STREAM SIDE

Scale 1/8" = 1'-0"

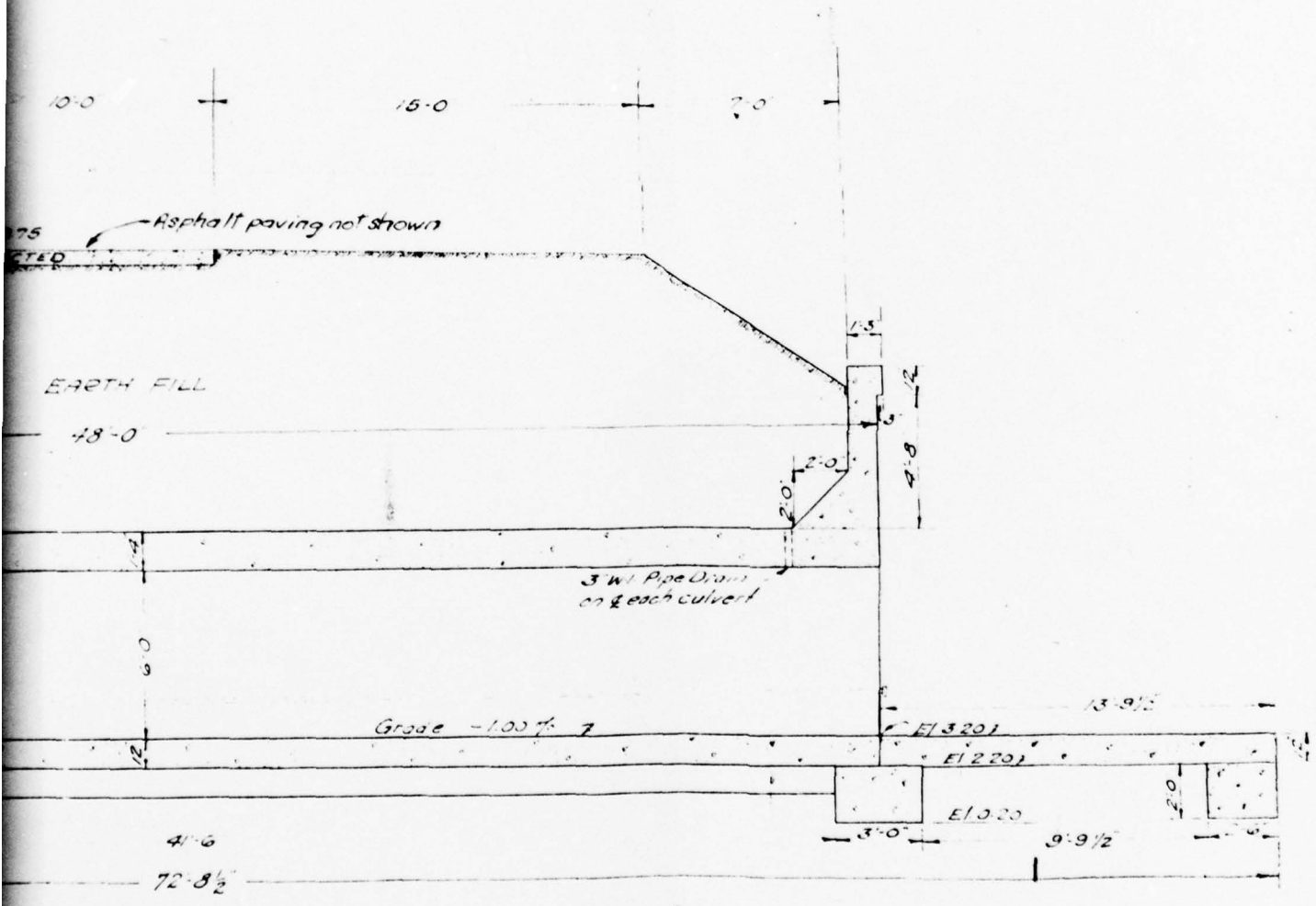
ELEVATION
OF
SIPHON SPILLWAY

FIGURE 4

2



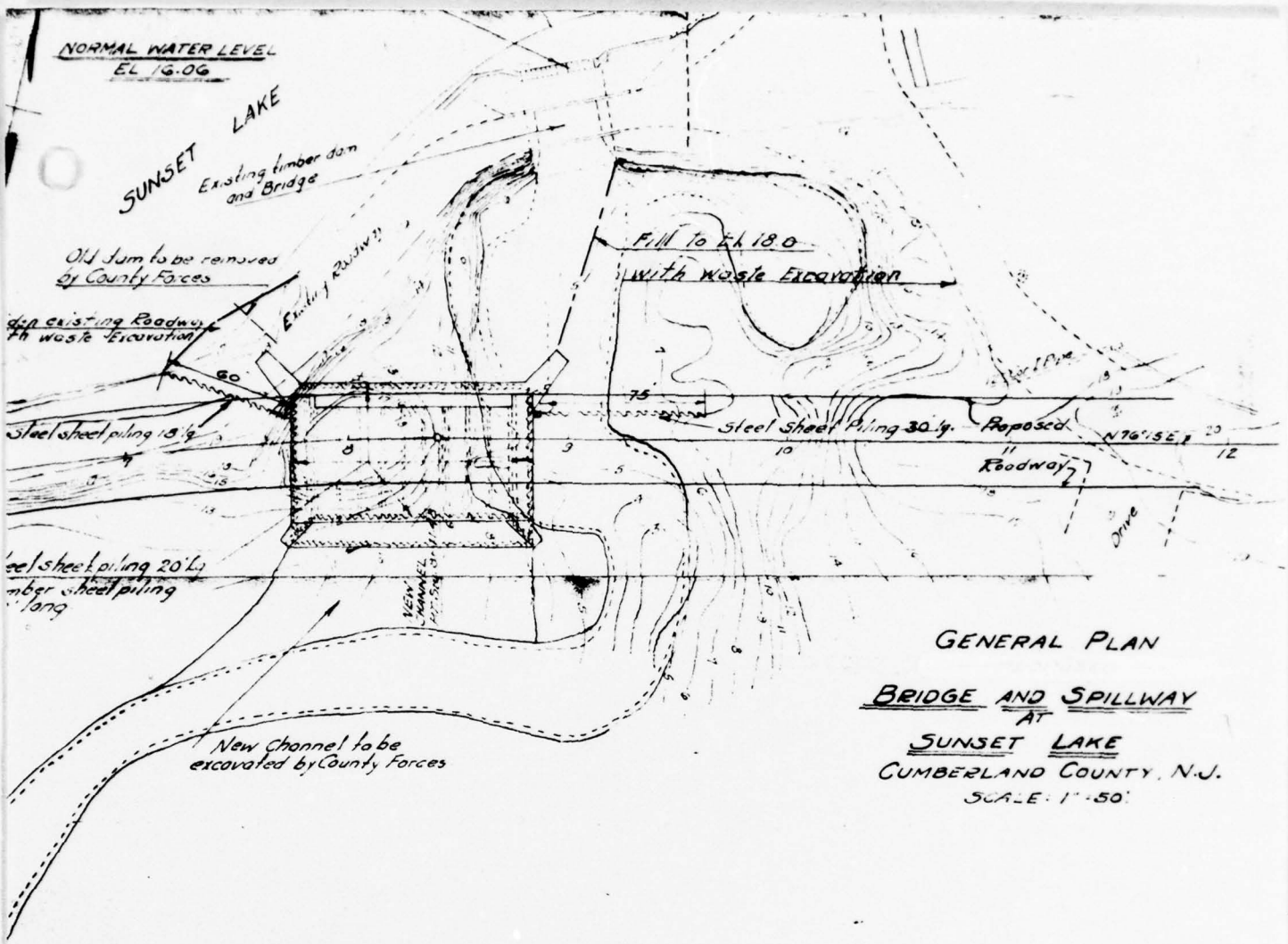
CROSS SECTION OF SIPHO
THRU UNIT NO.
Scale: 1/4" = 1'



ION OF SIPHON SPILLWAY
THRU UNIT No. 5
Scale: 1/4" = 1'-0

FIGURE 5

2


NORMAL WATER LEVEL
EL 16.06
SUNSET LAKE
Existing timber dam and Bridge
Old Dam to be removed by County Forces
Existing Roadway
Fill to El. 18.0
with waste Excavation
Steel Sheet Piling 30' Lg.
Proposed
Roadway
N 76° 15' E
Steel sheet piling 18' Lg
Steel sheet piling 20' Lg
New Channel to be excavated by County Forces
GENERAL PLAN
BRIDGE AND SPILLWAY
AT
SUNSET LAKE
CUMBERLAND COUNTY, N.J.
SCALE: 1" = 50'

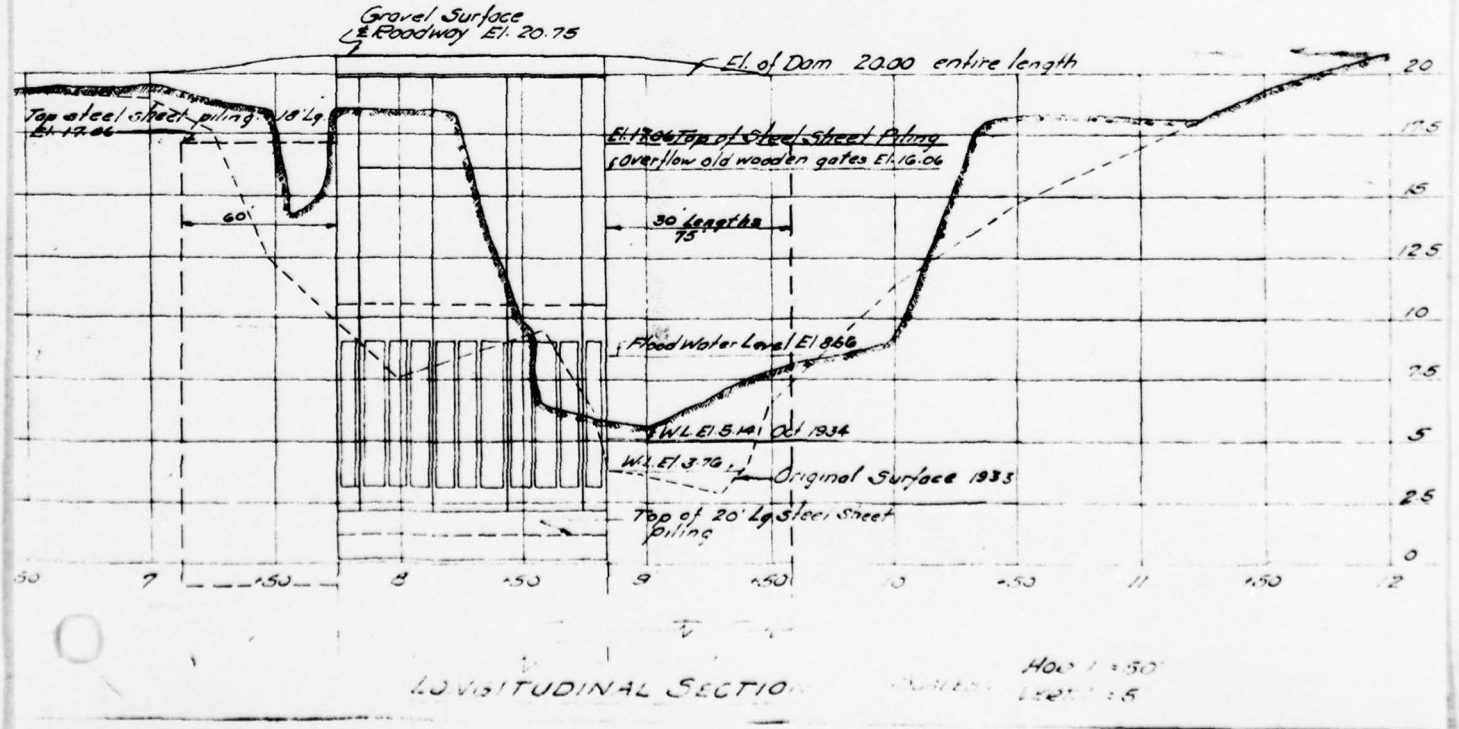

Gravel Surface
Roadway El. 20.75
El. of Dam 20.00 entire length
Top steel sheet piling 18' Lg
El. 17.06
El. 16.06 Top of Steel Sheet Piling
Overflow old wooden gates El. 16.06
60'
30' Length
75'
Flood Water Level El. 8.66
W.L. El. 5.14 Oct. 1934
W.L. El. 3.70
Original Surface 1935
Top of 20' Lg Steel Sheet Piling
LONGITUDINAL SECTION
Hor. 1" = 50'
Ver. 1" = 5'

FIGURE 6

Check List
Visual Inspection
Phase 1

Name Dam Sunset Lake Dam County Cumberland State New Jersey Coordinators NJDEP

Date(s) Inspection 10,11 Jan. 1979
24 Feb. 1979 Weather Cloudy Temperature 20°

Pool Elevation at Time of Inspection +16.0 M.S.L. Tailwater at Time of Inspection +2 M.S.L.

Inspection Personnel:

K. Jolls

R. Lang

E. Simone

K. Jolls Recorder

CONCRETE/MASONRY DAMS

(NOTES AT MAIN SIPHON SPILLWAY)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEE PAGE ON LEAKAGE		
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Satisfactory - roadway embankment section.	Major 2 lane road (asphalt) passes over spillway culvert.
DRAINS	None	Roadway drains located in east wingwall.
WATER PASSAGES	None	
FOUNDATION	Satisfactory	Spillway structure in sheeted cofferdam.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Wingwalls have several cracks. Concrete surfaces eroded and spalled in some areas.	
STRUCTURAL CRACKING	Several major cracks in wingwalls	
VERTICAL AND HORIZONTAL ALIGNMENT	Satisfactory - county bridges	B-14 is at west end of roadway embankment
MONOLITH JOINTS	N/A	
CONSTRUCTION JOINTS	Appear in old condition but satisfactory.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed at crest. (Roadway recently repaved)	Downstream shoulder slopes severely eroded in some areas.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	Upstream toe completely under water.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Bad erosion at siphon spillways from roadway runoff. Erosion along raceway embankment due to pedestrian traffic. Bad undercutting of fill behind siphon wingwalls.	
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Satisfactory along Park Drive (roadway fairly level at El. 20±)	Backslopes on main Park Avenue embankment vary widely (almost vertical to 2:1)
RIPRAP FAILURES	None	Random stone dumped on backslopes of main and raceway embankment.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Satisfactory	Main (Park Ave) embankment turns south at bridge B-14 and continues along "Bridgetown" millrace.
ANY NOTICEABLE SEEPAGE	Yes 1) some to right of siphon spillways 2) numerous areas along upper end of raceway dike.	
STAFF GAGE AND RECORDER	None	
DRAINS	None	Numerous old intake and structures along lower end of raceway (all sealed up).

OUTLET WORKS MAIN SPILLWAY (Continued remarks from page 1)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Minor spalling at edges.	Concrete in good condition in view of its age.
INTAKE STRUCTURE	Covered with steel or W.I. trash bars. Satisfactory condition. Bridge parapet recently painted.	Note: absence of log boom or floating device to keep debris or ice from siphon air vents.
OUTLET STRUCTURE	Satisfactory. Culvert opening discharge into large stilling basin undercut 3-5'.	
OUTLET CHANNEL	Main channel of Cohansey River	Heavily wooded downstream area.
EMERGENCY GATE	2-4x5 sluices on each side of siphon. Hand-operated gears and gates on upstream face of siphon structure (see plans)	Exit velocities appear high and scoured out stilling basin.

UNGATED SPILLWAY (AT RACEWAY)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	3 notched openings at raceway gate at south end. Old concrete numerous cracks and spalls	Rebuilt near Washington St. directly before nail museum.
APPROACH CHANNEL	20-30' channel	Built 1814
DISCHARGE CHANNEL	Elliptical lines (2) discharge as chute into Cohansey River.	
BRIDGE AND PIERS	Small wooden and steel bridge on Mayor Aitken Drive - just above drop inlet. Satisfactory condition.	

GATED SPILLWAY (AUXILIARY SPILLWAY - MAIN EMBANKMENT)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Satisfactory - some chipping on drop inlet at top (weir).	
APPROACH CHANNEL	Main body of lake	
DISCHARGE CHANNEL	Natural channel (ties back into main river channel downstream)	Large stilling basin scoured out below the outlet headwall (excess velocity).
BRIDGE AND PIERS	None - inlet of weir and lower gate discharge into 5x9 concrete culvert.	
GATES AND OPERATION EQUIPMENT	Satisfactory. Maintenance appears good.	Freshly painted.

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER		

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Flat	Well-defined shoreline. Small park immediately above left abutment.
SEDIMENTATION	Unknown (surface was frozen)	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Wooded, some debris Three city bridges downtown	Lower portion of river channel has bulkheads in vicinity of Washington Ave.
SLOPES	Very gradual	Tidal backwater reaches up to siphon spillway.
APPROXIMATE NO. OF HOMES AND POPULATION	City of Bridgeton 1 mi. downstream (numerous houses and businesses) Zoo, park facilities, City Water building located below raceway dike.	Practically all residential areas above high water elevation.

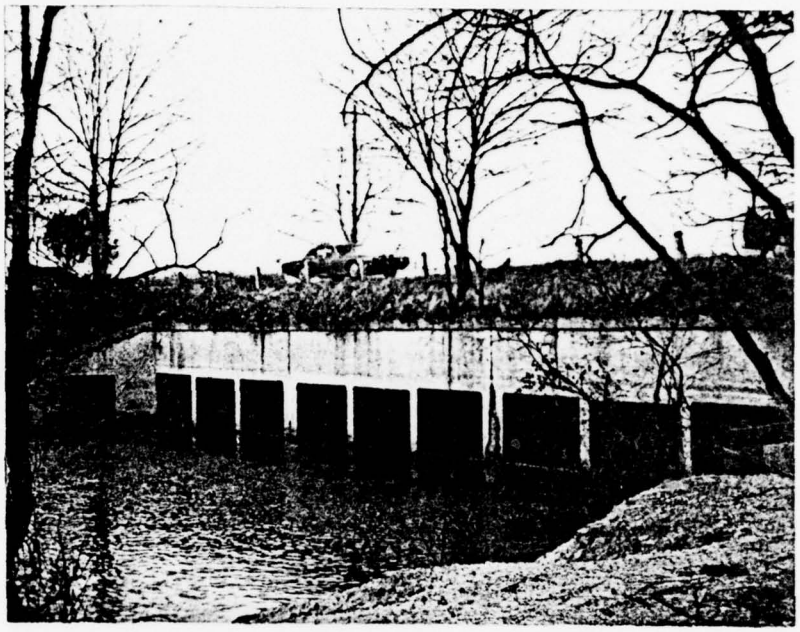
CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS	
PLAN OF DAM	Available *	*NJDEP Trenton, N.J.
REGIONAL VICINITY MAP	Available	
CONSTRUCTION HISTORY	Known	
TYPICAL SECTIONS OF DAM	None Available	
HYDROLOGIC/HYDRAULIC DATA	Some available *	
OUTLETS - PLAN	Available *	
- DETAILS	Available *	
-CONSTRAINTS	Known	
-DISCHARGE RATINGS	Known	
RAINFALL/RESERVOIR RECORDS	Some available *	

ITEM	REMARKS
DESIGN REPORTS	
GEOLOGY REPORTS	None available
DESIGN COMPUTATIONS	Available *
HYDROLOGY & HYDRAULICS	
DAM STABILITY	None Available
SEEPAGE STUDIES	None Available
MATERIALS INVESTIGATIONS	None Available
BORING RECORDS	None Available
LABORATORY	None Available
FIELD	None Available
POST-CONSTRUCTION SURVEYS OF DAM	Unknown
BORROW SOURCES.	Unknown

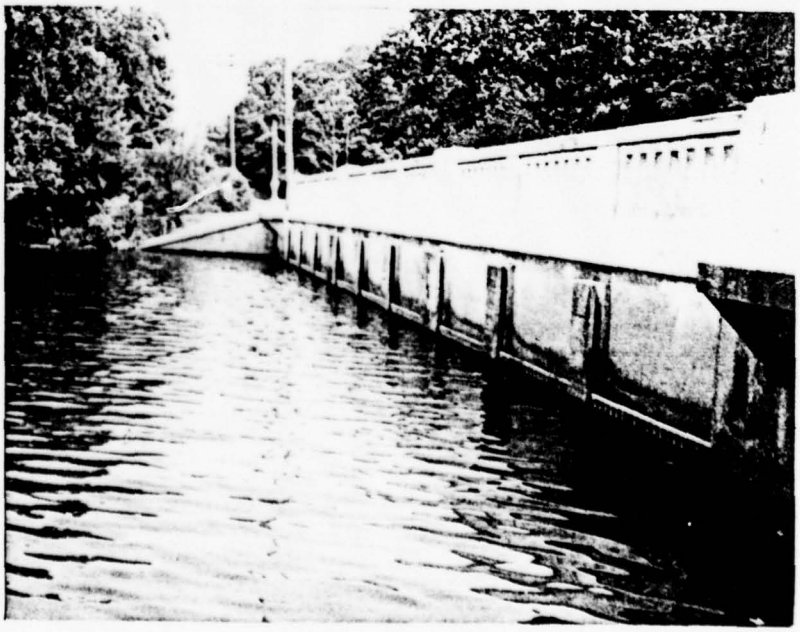
ITEM	REMARKS
MONITORING SYSTEMS	Unknown
MODIFICATIONS	Known
HIGH POOL RECORDS	Known
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None Available
PRIOR ACCIDENTS OR FAILURE OF DAM	Known
DESCRIPTION	Available *
REPORTS	Available *
MAINTENANCE	Known
OPERATION	Known
RECORDS	None Available

ITEM	REMARKS
SPILLWAY PLAN	Available *
SECTIONS	Available *
DETAILS	Available *
OPERATING EQUIPMENT PLANS & DETAILS	Available *



Outlets from siphon spillways

January 1979



Intakes for siphon spillways

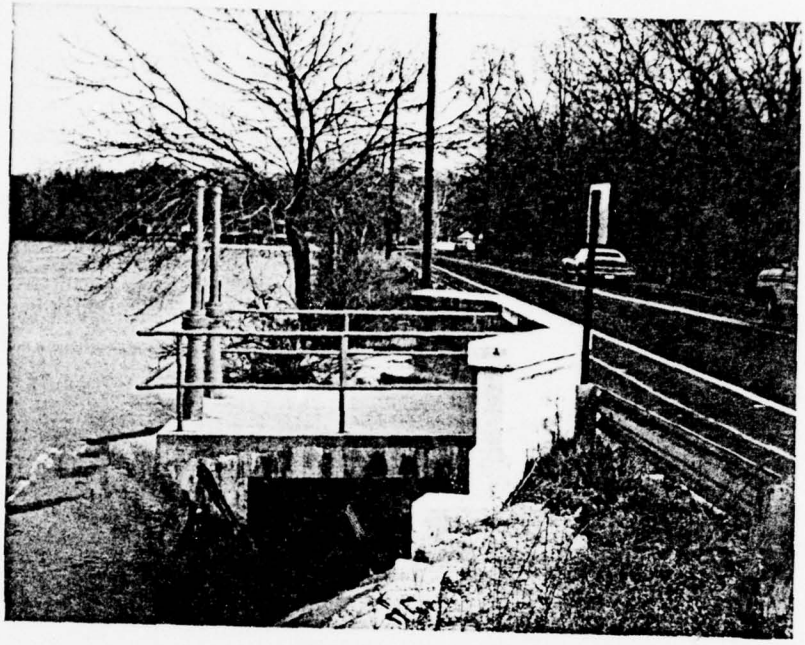
September 1978

Bridge over raceway near right abutment

January 1979

Raceway immediately downstream of bridge

January 1979

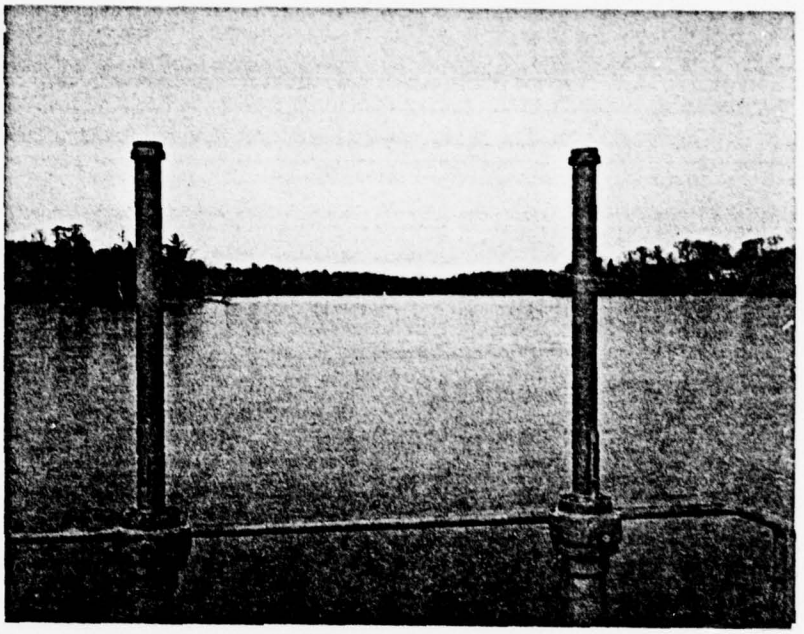


Auxiliary spillway and gates

January 1979

Outlet from auxiliary spillway

January 1979



Sunset Lake

January 1979

Downstream channel

September 1978

Cohansey River at high tide

January 1979

Cohansey River at raceway outlet

(Note: overtopping of concrete wall)

January 1979

Box culvert at end of raceway

January 1979

Discharge from raceway into Cohansey River

January 1979

Raceway as seen from Atlantic Street bridge

January 1979

Arch bridge over raceway in park

January 1979

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Drainage Area = 45.7 sq. mi.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): +16.06 (310 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): +20.00 (835 acre-feet)

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: +20.0

CREST: 2 lane paved roadway on main embankment.

Main spillway:

a. Elevation +16.06
b. Type Siphon spillway, Auxiliary spillway
c. Width 2"-6"
d. Length 72'
e. Location Spillover Near left abutment
f. Number and Type of Gates 9 2'-6" x 8'-0" throats in siphons.

OUTLET WORKS: Auxiliary spillways 1) main dam 2) raceway

a. Type 1) vertical lift sluice gates 2) notched weirs
b. Location at either end of siphons and at spillway 800' west of siphons
c. Entrance inverts varies
d. Exit inverts varies
e. Emergency draindown facilities 2-4' x 5' gates; 2-42" Ø sluices

HYDROMETEOFOLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 5400 cfs.

BY D J M DATE 1-79 LOUIS BERGER & ASSOCIATES INC. SHEET NO. A1 OF

CHKD. BY DATE SUBJECT SUNSET LAKE DAM #1 PROJECT C226

SNYDER COEFFICIENTS (FROM CORPS OF ENGINEERS)

$C_t = 4.51$ } from Corps

$C_p = 0.70$ }

Length of longest water course $L = 8.71$ miles

Length to centroid $L_c = 3.54$ miles

$t_p = C_t (L L_c)^{0.3}$

$= 4.51 (8.71 \times 3.54)^{0.3} = 12.61$ hours

PRECIPITATION

PMF for 200 square miles & 24 hours duration = 2[illegible]

Max 6 hour percentage = 98%

" 12 " " = 107%

" 24 " " = 117%

BY D.J.N. DATE 1-11

CHKD. BY _____ DATE _____

SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A2 OF _____

PROJECT 6226

Sunset Lake Dam Intervention

Discharge over apron @ out flow

$L = 120'$

H	C	Q
1	3.1	372
2	3.1	1052
3	3.1	1933
4	3.1	2976
5	3.1	4159
6	3.1	5467
7	3.1	6890
8	3.1	8417

Flow through siphons

UNITS 1 & 9 Elevation of lake = 16.06

tailwater based on above discharge over apron

Width = 8' D = 2.5'

Elev	Tailwater El.	ΔH	C	A = W×D ×2	Q	Q Through Sluice
17.06	10.0	7.06	0.7	40	597	469
18.06	10.1	7.96	0.7	40	634	498
19.06	10.2	8.86	0.7	40	669	526
20.06	10.3	9.76	0.7	40	702	552
21.06	10.4	10.66	0.7	40	734	576
22.06	10.5	11.56	0.7	40	764	600
23.06	10.6	12.46	0.7	40	793	623
24.06	10.7	13.36	0.7	40	821	655
25.06	10.8	14.26	0.7	40	848	676

Assume siphons are all at the same elevation

∴ Through 9 siphons discharge = 4.5 x the above

BY D J M DATE 1-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO A 3 OF

CHKD. BY ____ DATE ____ SUNSET LAKE DAM INSPECTION PROJECT C 226

SUBJECT SPILLWAY DISCHARGE CALCULATIONS CONT'D

Through 9 Siphons		Through 2 Sluices	Flow through bridge B14 @ start of raceway		Through 2 42" CMP	
H	Q	Q	El.	Q	H	Q
1	2687	469	17.06	461	5.3	195
2	2853	498	18.06	550	6.3	213
3	3011	526	19.06	1375	7.3	229
4	3159	552	20.06	1944	8.3	245
5	3303	576	21.06	2381	9.3	259
6	3438	600	22.06	2749	10.3	272
7	3569	623	23.06	3074	11.3	286
8	3694	655	24.06	3503	12.3	298
9	3816	676	25.06	4020	13.3	310

Flow over dam
@ El. 20.0 L=1200

H'	c	Q
0.06	2.7	48
1.06	2.7	3536
2.06	2.7	9580
3.06	2.7	17343
4.06	2.7	26505
5.06	2.7	36878

ΣQ

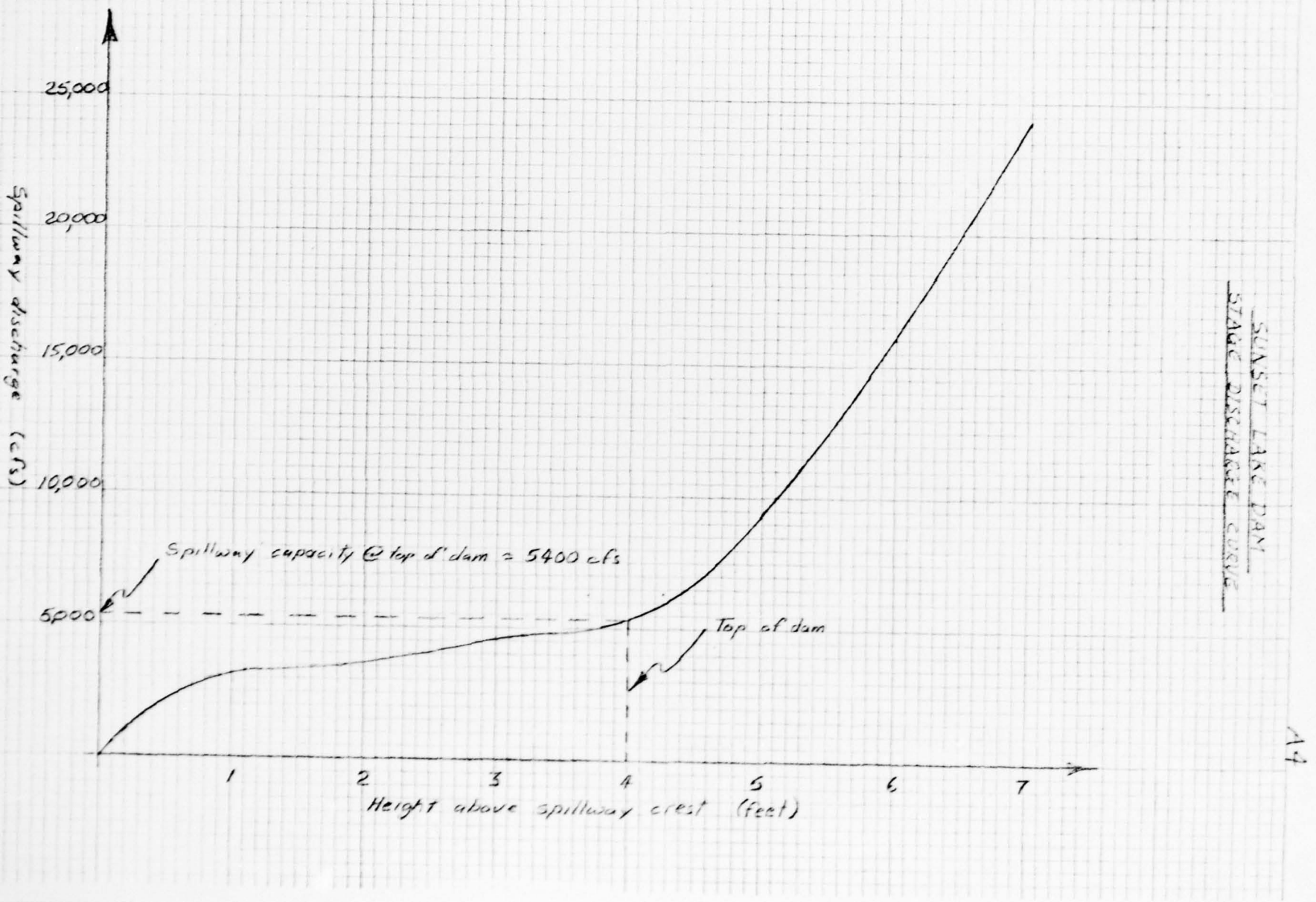
H	Q
1	3,343
2	3,616
3	4,615
4	5,396
5	9,479
6	16,039
7	24,271
8	34,000
9	45,024

Flow through bridge opening calculated using Mannings formula untill bridge superstructure starts to be submerged, then the following formula used :-

$$Q = 0.80\, b_N Z\, (2g\Delta h)^{1/2}$$

(page 44 "Hydraulics of Bridge Waterways" U.S Department of Transportation)

K&E 10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.



BY D.J.M. DATE 1-79

CHKD. BY _____ DATE _____

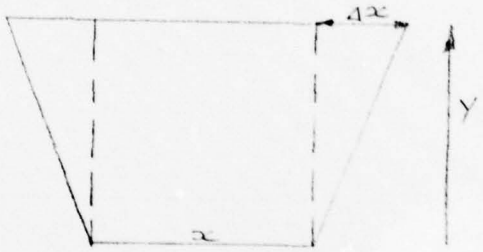
SUBJECT SUNSET LAKE DAM INSPECTION
SURCHARGE STORAGE

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 15 OF _____

PROJECT C-226

AREA OF LAKE @ El. 160 = 93 a
AREA OF CONTOUR @ El. 200 = 168.7
" " " @ El. 300 = 389.8



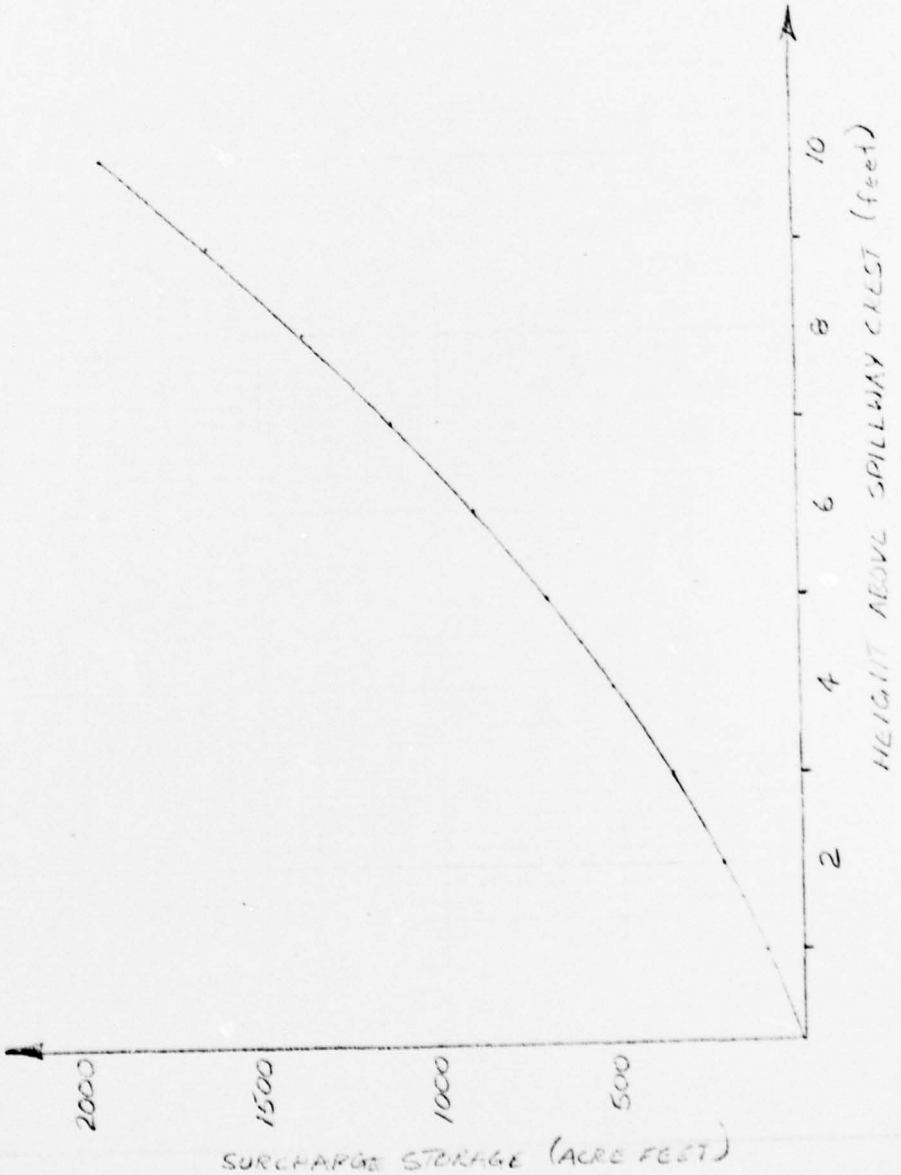
Increment in volume $\Delta v = (x + \Delta x)y$

HEIGHT ABOVE CREST (Feet)	STORAGE (Acre feet)
1	103
2	224
3	365
4	524
5	704
6	906
7	1150
8	1376
9	1644
10	1934

BY D.J.M. DATE 1-79
CHKD. BY DATE

SUBJECT STAGE STORAGE CURVE
SUNSET LAKE DAM INSPECTION

SHEET NO. A6 OF
JOB NO. C226



BY D.J.M. DATE 4-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A7 OF

CHKD. BY DATE SUNSET LAKE DAM INSPECTION PROJECT 6226

SUBJECT Approximate Drawdown Calculation

Assume drawdown through two sluices (5' x 4')

Volume of lake = 310 acre feet = 13,503 600 ft³

invert of sluices @ El. 3.7
assume tailwater @ El. 4.5
assume inflow of 90 cfs (= 2 cfs/sq mile)

Assume ½ volume drawn down under head of 8.63' and ½ volume drawn down under head of 2.88'

i) $h = 8.63'$ $Q = 0.55 \times 40 \sqrt{64.32 \times 8.63} - 90$
$= 428$ cfs

$$\text{time} \approx \frac{13503600}{2 \times 428 \times 3600} \approx 4.38 \text{ hours}$$

ii) $h = 2.88'$ $Q = 0.55 \times 40 \sqrt{64.32 \times 2.88}$
$= 209$ cfs

$$\text{time} \approx \frac{13503600}{2 \times 209 \times 3600} \approx 9.0 \text{ hours}$$

Σ time $\approx$ 13.4 hours

SUNSET LAKE DAM INSPECTION SOUTH GROUP C226
BY D.J.MULLIGAN
JANUARY 1979

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	1	0	0	0	0	0	0	0	0

JOPER NWT
5 0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 2 LRTIO= 1
RTIOS= 1.00 0.50

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
11	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	45.70	0.0	45.70	0.0	0.0	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	24.00	98.00	107.00	117.00	0.0	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.847

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	0.50	0.10	0.0	0.0

UNIT HYDROGRAPH DATA
TP= 12.61 CP=0.70 NTA= 0

RECESSION DATA
STRTQ= 0.0 QRCSN= 0.0 RTIOR= 1.00
APPROXIMATE CLARK COFFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=14.58 AND R= 9.24 INTERVALS

UNIT HYDROGRAPH 57 END-OF-PERIOD ORDINATES, LAG= 12.55 HOURS, CP= 0.70 VOL= 1.00

38.	143.	290.	459.	642.	833.	1030.	1224.	1393.	1522.
1612.	1664.	1677.	1647.	1554.	1412.	1267.	1137.	1020.	915.
821.	737.	661.	593.	533.	478.	429.	385.	345.	310.
278.	249.	224.	201.	180.	162.	145.	130.	117.	105.
94.	84.	76.	68.	61.	55.	49.	44.	40.	36.
32.	29.	26.	23.	21.	19.	17.			

END-OF-PERIOD FLOW
TIME RAIN EXCS COMP Q

BY DJM DATE 4-79
CHKD. BY DATE
SUBJECT Sunset Lake Dam Insp. HEC-1

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 48 OF
PROJECT C226

BY DJM DATE 4-79

CHKD. BY _____ DATE _____

SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

Sunset Lake Dam Insp.

HEC-1

SHEET NO. 22 OF _____

PROJECT C226a

1	0.14	0.00	0.
2	0.14	0.00	0.
3	0.14	0.00	0.
4	0.14	0.01	0.
5	0.14	0.04	3.
6	0.14	0.04	10.
7	0.30	0.20	28.
8	0.30	0.20	71.
9	0.30	0.20	145.
10	0.30	0.20	255.
11	0.30	0.20	402.
12	0.30	0.20	589.
13	1.99	1.89	879.
14	2.39	2.29	1398.
15	2.99	2.89	2261.
16	7.57	7.47	3730.
17	2.79	2.69	5974.
18	2.19	2.09	8870.
19	0.20	0.10	12216.
20	0.20	0.10	15806.
21	0.20	0.10	19466.
22	0.20	0.10	23037.
23	0.20	0.10	26354.
24	0.20	0.10	29195.
25	0.0	0.0	31383.
26	0.0	0.0	32835.
27	0.0	0.0	33487.
28	0.0	0.0	33310.
29	0.0	0.0	32333.
30	0.0	0.0	30567.
31	0.0	0.0	28215.
32	0.0	0.0	25663.
33	0.0	0.0	23182.
34	0.0	0.0	20893.
35	0.0	0.0	18814.
36	0.0	0.0	16926.
37	0.0	0.0	15213.
38	0.0	0.0	13661.
39	0.0	0.0	12260.
40	0.0	0.0	11002.
41	0.0	0.0	9872.
42	0.0	0.0	8859.
43	0.0	0.0	7949.
44	0.0	0.0	7133.
45	0.0	0.0	6401.
46	0.0	0.0	5744.
47	0.0	0.0	5154.
48	0.0	0.0	4625.
49	0.0	0.0	4150.
50	0.0	0.0	3724.
51	0.0	0.0	3342.
52	0.0	0.0	2999.
53	0.0	0.0	2691.
54	0.0	0.0	2415.
55	0.0	0.0	2167.
56	0.0	0.0	1944.
57	0.0	0.0	1745.
58	0.0	0.0	1566.
59	0.0	0.0	1405.
60	0.0	0.0	1261.
61	0.0	0.0	1131.

LOUIS BERGER & ASSOCIATES INC.

62	0.0	0.0	1015.
63	0.0	0.0	910.
64	0.0	0.0	813.
65	0.0	0.0	727.
66	0.0	0.0	649.
67	0.0	0.0	579.
68	0.0	0.0	517.
69	0.0	0.0	461.
70	0.0	0.0	385.
71	0.0	0.0	311.
72	0.0	0.0	236.
73	0.0	0.0	101.
74	0.0	0.0	50.
75	0.0	0.0	14.
76	0.0	0.0	11.
77	0.0	0.0	8.
78	0.0	0.0	6.
79	0.0	0.0	4.
80	0.0	0.0	2.
81	0.0	0.0	0.
82	0.0	0.0	0.
83	0.0	0.0	0.
84	0.0	0.0	0.
85	0.0	0.0	0.
86	0.0	0.0	0.
87	0.0	0.0	0.
88	0.0	0.0	0.
89	0.0	0.0	0.
90	0.0	0.0	0.
91	0.0	0.0	0.
92	0.0	0.0	0.
93	0.0	0.0	0.
94	0.0	0.0	0.
95	0.0	0.0	0.
96	0.0	0.0	0.
97	0.0	0.0	0.
98	0.0	0.0	0.
99	0.0	0.0	0.
100	0.0	0.0	0.
SUM	23.76	21.21	623509.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	33487.	32319.	21857.	8660.	623508.
INCHES		6.58	17.80	21.15	21.15
AC-FT		16034.	43374.	51555.	51556.

HYDROGRAPH AT STA 11 FOR PLAN 1, RTIO 1

0.	0.	0.	0.	3.	10.	28.	71.	145.	255.
402.	589.	879.	1398.	2261.	3730.	5974.	8870.	12216.	15806.
19466.	23037.	26354.	29195.	31383.	32835.	33487.	33310.	32333.	30567.
28215.	25663.	23182.	20893.	18814.	16926.	15213.	13661.	12260.	11002.
9872.	8859.	7949.	7133.	6401.	5744.	5154.	4625.	4150.	3724.
3342.	2999.	2691.	2415.	2167.	1944.	1745.	1566.	1405.	1261.
1131.	1015.	910.	813.	727.	649.	579.	517.	461.	385.
311.	236.	101.	50.	14.	11.	8.	6.	4.	2.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	33487.	32319.	21857.	8660.	623508.

INCHES	6.58	17.80	21.15	21.15	
AC-FT	16034.	43374.	51555.	51556.	

HYDROGRAPH AT STA 11 FOR PLAN 1, RTIO 2

0.	0.	0.	0.	1.	5.	14.	35.	72.	127.
201.	294.	439.	699.	1131.	1865.	2987.	4435.	6108.	7903.
9733.	11518.	13177.	14598.	15691.	16417.	16743.	16655.	16167.	15283.
14107.	12832.	11591.	10447.	9407.	8463.	7607.	6830.	6130.	5501.
4936.	4429.	3975.	3567.	3201.	2872.	2577.	2313.	2075.	1862.
1671.	1499.	1346.	1207.	1083.	972.	872.	783.	703.	630.
566.	507.	455.	407.	363.	325.	290.	258.	230.	193.
156.	118.	50.	25.	7.	5.	4.	3.	2.	1.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	16743.	16159.	10926.	4330.	311753.
INCHES		3.29	8.90	10.58	10.58
AC-FT		8017.	21687.	25777.	25778.

HYDROGRAPH ROUTING

ROUTING THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
111	1	0	0	0	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	0	0	0.0	0.0	0.0	0.

STORAGE=	0.	103.	224.	365.	524.	611.	704.	906.	1130.	1376.
OUTFLOW=	0.	3343.	3616.	4615.	5396.	7400.	9479.	16039.	24271.	34000.

STATION 111, PLAN 1, RTIO 1

0.	0.	0.	0.	2.	7.	21.	54.	116.	212.
345.	517.	765.	1193.	1923.	3152.	3604.	5136.	9957.	14603.
18185.	21883.	25303.	28369.	30751.	32436.	33335.	33414.	32679.	31154.
28966.	26451.	23944.	21645.	19485.	17538.	15781.	14241.	12774.	11464.
10287.	9271.	8439.	7577.	6790.	6090.	5465.	5226.	4943.	4600.
4117.	3688.	3499.	3309.	2143.	2043.	1816.	1632.	1464.	1314.
1179.	1057.	948.	849.	759.	678.	605.	540.	481.	415.
339.	265.	155.	64.	27.	10.	9.	7.	4.	2.
1.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STOR

0.	0.	0.	0.	0.	0.	1.	2.	4.	7.
11.	16.	24.	37.	59.	97.	219.	471.	719.	862.
964.	1065.	1156.	1234.	1294.	1336.	1359.	1361.	1343.	1304.
1249.	1185.	1121.	1059.	1000.	947.	898.	851.	805.	765.
729.	695.	657.	619.	585.	554.	527.	489.	432.	383.
295.	234.	172.	102.	66.	63.	56.	50.	46.	40.
36.	33.	29.	26.	23.	21.	19.	17.	15.	13.
10.	8.	5.	2.	1.	0.	0.	0.	0.	0.
0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

BY RJM DATE 4-79

CHKD. BY _____ DATE _____

SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

Sunset Lake Dam Trib.

HEC-1

SHEET NO. 111 OF

PROJECT C2236

-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	33414.	32295.	21830.	8660.	623508.
INCHES		6.57	17.77	21.15	21.15
AC-FT		16022.	43321.	51555.	51556.

STATION 111, PLAN 1, RTIO 2

0.	0.	0.	0.	1.	3.	10.	27.	58.	106.
173.	259.	383.	596.	961.	1576.	2550.	3423.	3941.	5147.
8243.	10735.	12583.	14078.	15300.	16171.	16665.	16706.	16350.	15618.
14561.	13310.	12051.	10868.	9790.	8919.	8070.	7250.	6499.	5832.
5340.	5118.	4809.	4405.	3942.	3584.	3438.	2842.	2099.	1950.
1740.	1563.	1402.	1258.	1129.	1013.	909.	816.	732.	657.
589.	529.	474.	424.	379.	339.	303.	270.	241.	207.
169.	132.	77.	32.	14.	5.	5.	3.	2.	1.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STOR

0.	0.	0.	0.	0.	0.	0.	1.	2.	3.
5.	8.	12.	18.	30.	49.	79.	138.	270.	473.
649.	743.	800.	846.	883.	910.	923.	924.	914.	893.
860.	822.	783.	747.	714.	679.	641.	604.	572.	543.
513.	467.	404.	335.	270.	210.	145.	88.	65.	60.
54.	48.	43.	39.	35.	31.	28.	25.	23.	20.
18.	16.	15.	13.	12.	10.	9.	8.	7.	6.
5.	4.	2.	1.	0.	0.	0.	0.	0.	0.
0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.
-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	16706.	16135.	10834.	4330.	311753.
INCHES		3.28	8.82	10.58	10.58
AC-FT		8005.	21500.	25777.	25778.

PEAK FLOW SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

			RATIOS APPLIED TO FLOWS	
OPERATION	STATION	PLAN	1.00	0.50
HYDROGRAPH AT	11	1	33487.	16743.
		2	5034.	3643.
ROUTED TO	111	1	33414.	16706.
		2	5034.	3643.